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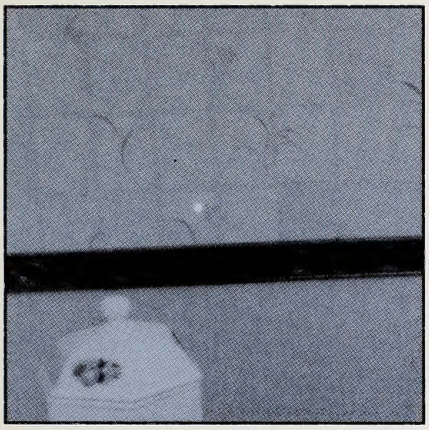
SCIENCE 14

MODULE 5: MIXING AND MEASURING



MODULE 5: MIXING AND MEASURING
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Distance Learning

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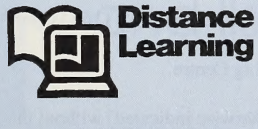
Science 14

Module 5

MIXING AND MEASURING



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Student Module
Module 5
Mixing and Measuring
Alberta Distance Learning Centre
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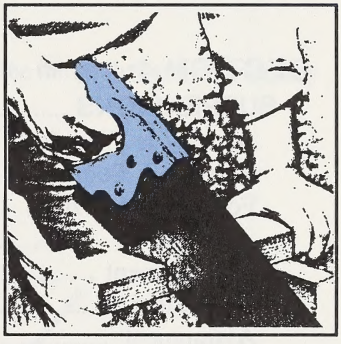

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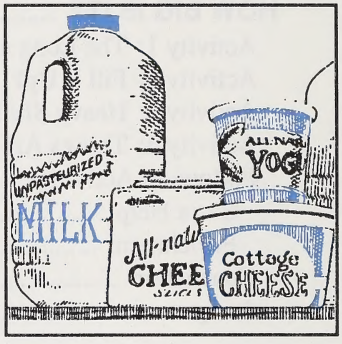
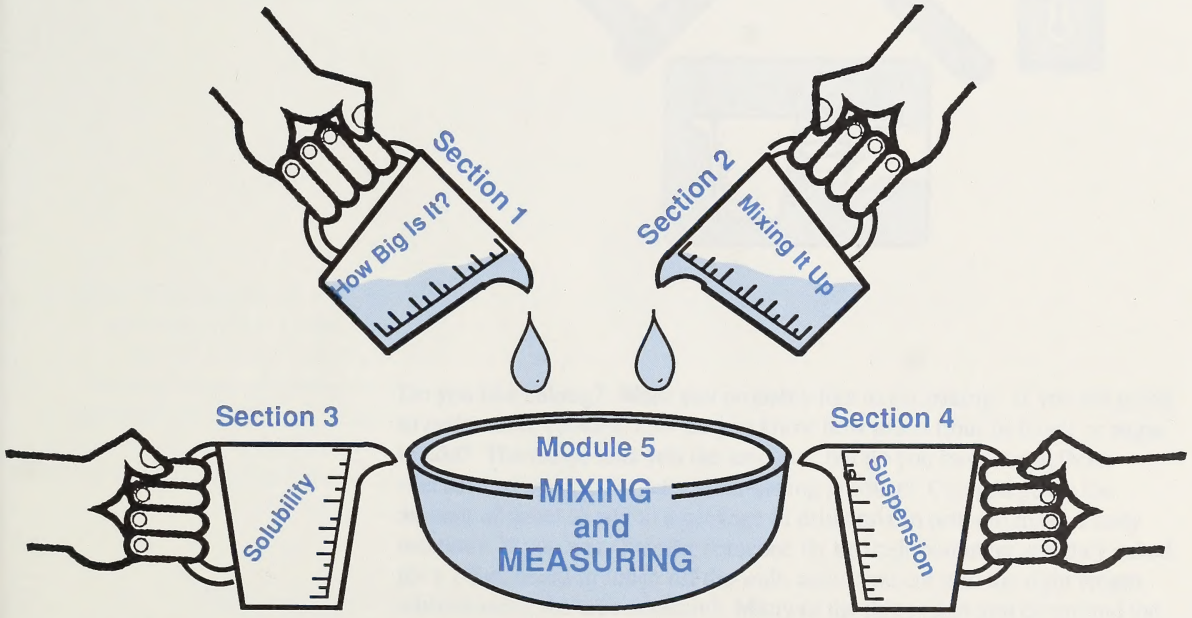


OVERVIEW

When you hear the word *science* do you think of people dressed in white lab coats lurking around in big rooms filled with beakers, test tubes, and bubbling concoctions? Science is not something which just happens in big factories or school laboratories. In fact, you have probably taken part in many activities in your own home without knowing that you were actually doing science. Cooking a meal, washing the car, cleaning your face, weighing yourself, and taking medicine are all ways that you may be using scientific processes. Even your house has been built using materials produced with scientific knowledge.

In this module you will learn how many of the things that you do everyday are based upon scientific principles.

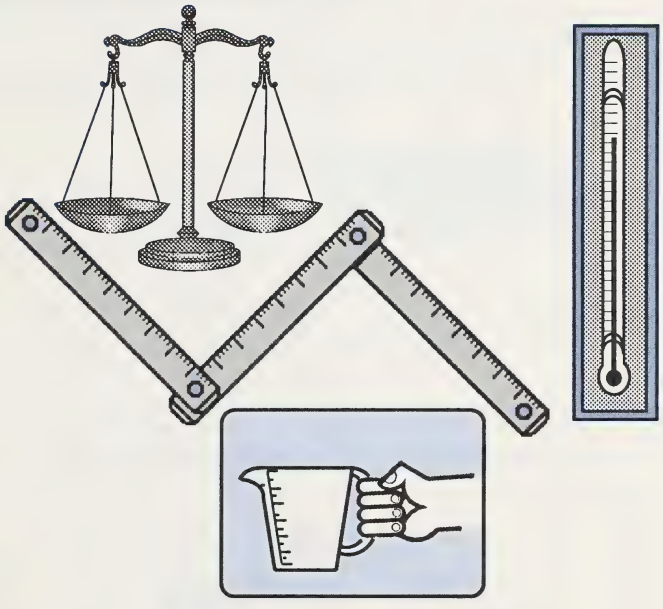


Evaluation

Your mark in this module will be determined by your work in the Assignment Booklet. You must complete all assignments. In this module you are expected to complete two section assignments. The assignment breakdown is as follows:

Section 1	=	30 marks
Section 2	=	22 marks
Section 3	=	25 marks
Section 4	=	23 marks
TOTAL	=	100 marks

1 How Big Is It?



Do you like baking? Well, you probably like to eat baking. If you are going to make some cookies, how do you know how much flour or butter or sugar to add? The recipe tells you the amounts, but do you have to put those specified amounts in to get a good-tasting product? Can you guess the amount of water to add to a package of drink mix in order to make a tasty mixture? If you were helping someone fix up their basement and they asked for a 1.5 m board to finish off the wall, could you cut it to the right length without using the tape measure? Many of the things that you do around the house require you to make either good estimations or accurate measurements.

In this section on measurement you will learn to use different measuring devices found in your home. You will also be able to decide if an accurate measurement is necessary in all situations.

Activity 1: The Long and the Short of It

What have you done today that required you to think about how far away or how long something was? The distance from your house to the school or store, the length of leg for the jeans you want to buy, how tall a tree is, the amount of rainfall overnight, or the length of nail to use when nailing down a certain thickness of plywood all involve some kind of length measurement.

1. List some things that you have done in the past week that involve the use of length.

_____

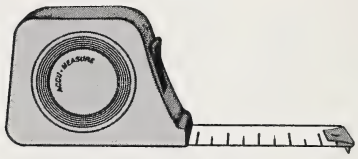
_____

_____

_____

_____

_____



SI (metric) system - a system of measurement based upon 10's; used in Canada for measurement

What units did you use to describe the length, width, thickness, or height of the things you listed? In Canada, a system of measurement called the SI (metric) system is used. The initials SI are the abbreviation for Le Système International d'Unités, an internationally accepted modern version of the metric system. If you used units like centimetre, millimetre, metre, and kilometre, you were using the metric system. The metric system is simply a standardized way of measuring how big or small, long or short, heavy or light, or hot or cold something is.

2. What type of units were you using for describing length?

_____

_____

_____

In the metric system, common units for measuring length are

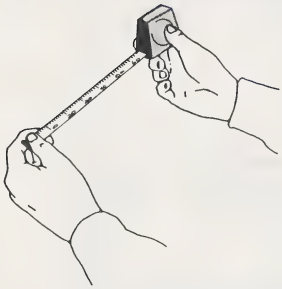
km – kilometre (1000 times larger than m)

m – metre (basic unit)

cm – centimetre (100 times smaller than m)

mm – millimetre (1000 times smaller than m)

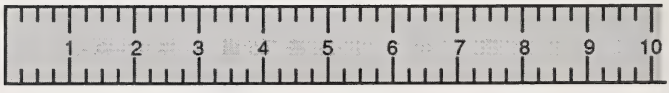
Note: To see how the metric units are related, check the Appendix, Diagram 1.



3. Using a metric ruler, metre stick, or metric tape measure, find the length of the following objects in and around your house. Use three different units (metre, centimetre, and millimetre) for each. Complete the following table with your measurements. For each measurement in the table, circle the unit that is most appropriate for each measurement.

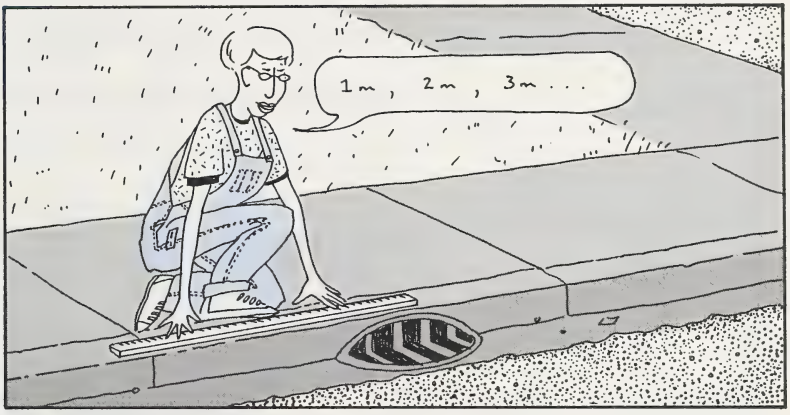
Measurement	m	cm	mm
height of a doorway			
your height			
length of a pencil			
length of a vehicle			
width of a piece of paper			
width of your window			
length of your foot			
width of a picture frame			
length of a nail or pin			
width of your bed			
width of your room			
length of your room			

Look at all the measurements of length that you made. Could you have used only the metre units and made meaningful measurements? Is it more useful to describe the length of a nail or pin in metres or in centimetres? Probably you have decided that some things are measured better in metres and other objects are so small that centimetres and millimetres are more reasonable.



estimation - a guess or rough calculation of an amount

When do you need to measure and when is a guess or **estimation** good enough? Could you have made some good estimations of the measurements you made? If you were asked to go and buy a picture frame for your school picture, could you make a good guess about the length and width of that picture and buy the proper-sized frame? Some people are very good at guessing, and if you are that type, you may have been able to guess what the right-sized frame is. Would it be better to measure?



Your friend asks you how far it is to your house. Will you go out with a metre stick and begin to accurately measure the distance? That would be ridiculous. An estimate is good enough for this type of measurement.

4. a. Look at the measurement you made for the width of a window. Give an example when an accurate measurement of the width of the windows is required. Give an example when an estimation would be enough.

_____

_____

_____

b. Give an example when an accurate measurement of the length of your foot is required. Give an example when an estimation would be enough.

_____

_____

_____

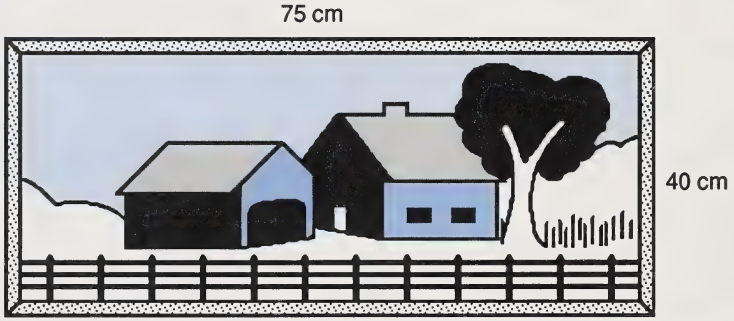
dimension - a measured amount like width, length, and height

area - the number of square units a surface occupies; $A = l \times w$

There are some situations where the measurement of length or width is not enough. The directions on a can of paint read "covers 10 – 12 m^2 per litre of paint." Carpet and linoleum are sold by the square metre. These measurements involve two dimensions – length and width. Whenever you see or hear units such as m^2, cm^2, or km^2, you know that the area of something is being described. The area of a baseball diamond is 700 m^2. The area of a five dollar bill is 102 cm^2. When have you read or heard about the area of something? Is it a common unit?

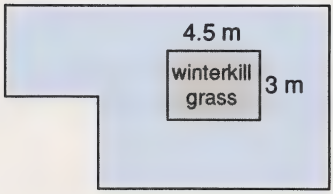
Area is determined by multiplying the width by the length.

Here is an example of an area calculation:



In this example, length = 75 cm
width = 40 cm

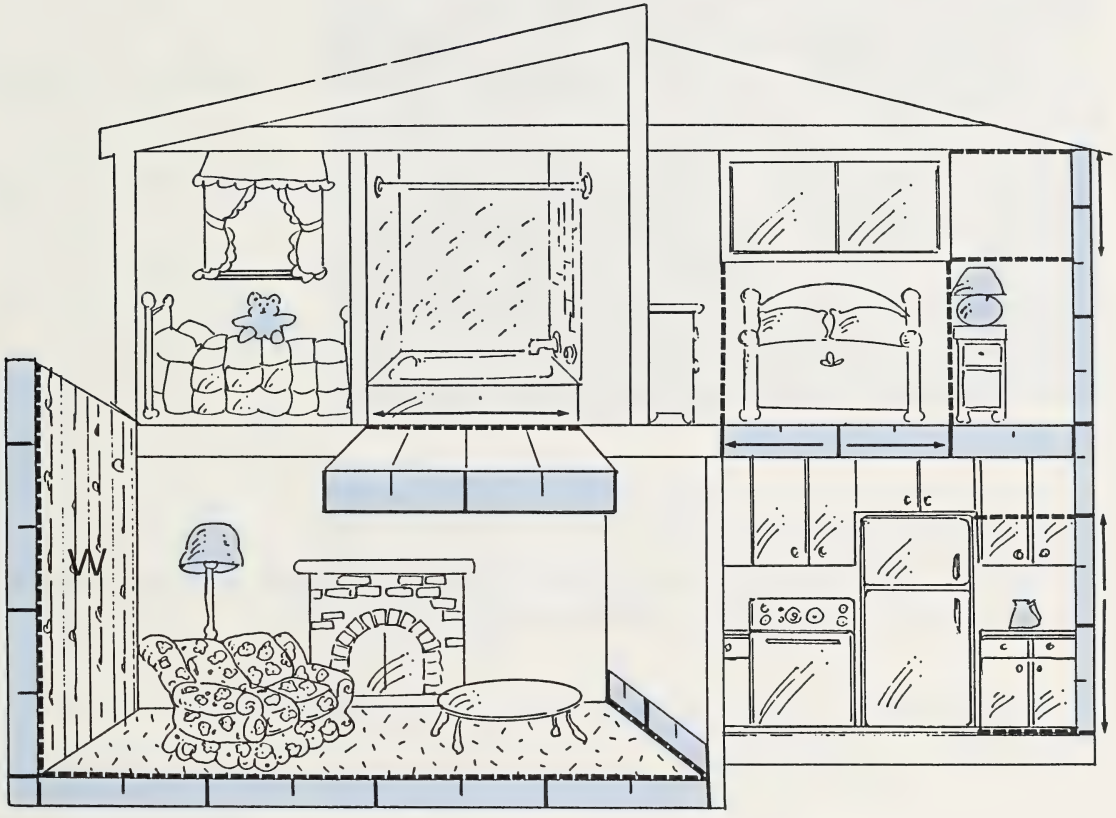
$A = l \times w$
$A = 75\ cm \times 40\ cm$
$A = 3000\ cm^2$



5. You want to help the family in resodding a patch of lawn that suffered severe winterkill. Find the area of the lawn which needs to be sodded, and state the number of square metres of sod which must be purchased to complete the job.

Can you think of more reasons to measure length now? There are many reasons, but there are also many other kinds of measurements.

Use the diagram to answer the following questions.



Each block ( ) represents one metre.

6. a. A blind is required for the master bedroom. Measure the window to determine size of blind that is required.

b. If you wanted to purchase a bath mat, the bath mat must be less than _____ metres in length.

c. A new wall-to-wall carpet is required for the living room. What area of carpet is required?

d. If you were to put wall paper on the livingroom wall labelled **W**, what area would you need to cover?

e. You wish to purchase a new refrigerator. How tall can the refrigerator be?

_____

_____

Check your answers by turning to the Appendix, Section 1: Activity 1.

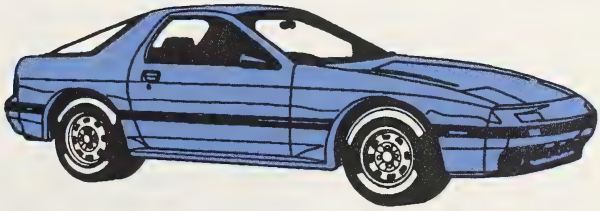
Activity 2: Fill It Up!

WESTFILE INC.

Have you gone to a gas station lately to get some gas for the car? As you watch the numbers go higher on the pump, you are watching the litres go in. Did you ever get under the car to see just how big your gas tank is? Can you find out how large it is? Most tanks hold about 40 L of gas. How much is that? You would have to pour the contents of twenty 2 L milk containers to fill a 40 L gas tank.

What is the engine size of the average vehicle? Is it measured in litres or millilitres? A 1600 engine means a 1600 mL engine. A 2 L engine means that the amount of space available for gasoline to burn in the engine is 2 L. The measurement that is being given is one of **volume**.

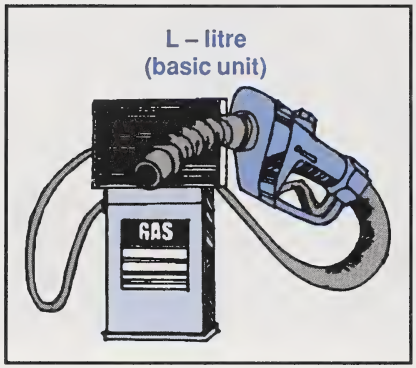
volume - a measure of the amount of space that something takes up

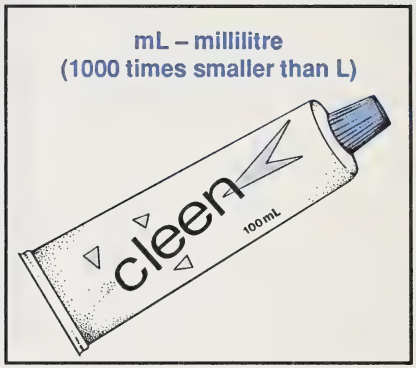


Look in your kitchen or garage. You will find many containers and products in there that are measured in terms of volume. Can you find volume-measuring devices?

The litre and units like it are used to measure volume. The two most common units for measuring volume are

Note: The litre symbol is written L not l.





Go back to the Appendix, Diagram 1 if you need to review the relationship of units.

1. Make a list of things in your home or garage measured in litres or millilitres.

_____

_____

_____

_____

_____

Are the things that you listed mostly liquids? Liquids are commonly measured in terms of how much space they occupy; this is called volume.

Do you do much cooking? How often do you use a measuring cup to add the proper amount of flour, sugar, or water to something you are making to eat?

WESTFILE INC.

Even if you don't cook, you may be interested in what is in the food you eat. Here are the ingredients listed for a chocolate chip cookie recipe:

Chocolate Chip Cookies

butter or margarine	250 mL
brown sugar	375 mL
eggs	2
vanilla	5 mL
flour	500 mL
cornstarch	60 mL
salt	4 mL
baking soda	5 mL
chocolate chips	500 mL
walnuts (chopped)	250 mL

Bake in a 180°C oven for 10 – 15 minutes.

What do you notice about almost all of the measurements? Did you see how many of the ingredients are measured in volume? Volume is a common measurement in baking. Most people have cups and spoons to measure volume in the kitchen. These devices have varying degrees of accuracy. Some people like to use unspecified devices to measure volume. Have you ever used a regular coffee cup to measure something in a recipe? Is it accurate enough?

You will find the answer to these questions by measuring the volume of different cups to see how much variation there is in their volumes.

Gather together at least five different coffee cups and a 500 mL measuring cup. Fill each cup as close to the top as you can and then pour the water into the measuring cup to determine the volume of each cup. Fill in the chart that follows.

Drawing of the Cup	Volume of Cup (in mL)

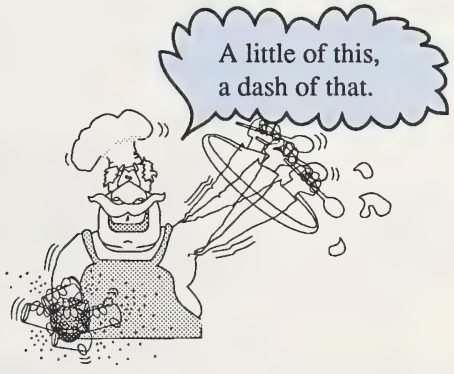
2. Were the cups that you chose close to the same volume? Could you use any of them for baking when an accurate measurement is required?

_____

_____

_____

If you were to do the same test with regular spoons and a measuring spoon, would you expect to find variation in the measurement? Have you ever seen a cooking program on television where the cook adds ingredients without measuring? The food always seems to turn out. Can you, or someone in your household, cook without measuring at all? For some people, accurate measurement in the kitchen is not necessary.



Investigation: Are You Getting What You Pay For?

If you buy a can of pop you can read the measured volume on it. Is that volume correct? Does it really matter to you? When you are buying a product you will want to get all that you are paying for. The government requires that the volume of contents be specified on the outside of containers. Are you getting the volume that the label says you are? You can test some beverage cans to see if the volume specified is actually the volume of the container.

Materials You Need

- various empty cans or bottles
- measuring cup
- water

Steps to Follow

STEP A

Find four different brand name drink cans or bottles. Note the volume measurement written on each container. Make sure the cans or bottles are empty, and fill each can or bottle with water. Do the companies that produce the drink always fill the container right up to the top?

STEP B

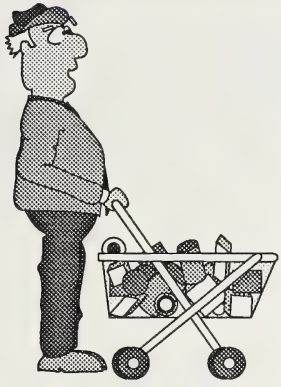
Use a measuring cup to determine the actual volume of each can. Fill in the observation table as you do the measurements.

STEP C

Compare the different soft drink cans by completing the following chart. In the last column put a – sign beside the difference if the measured volume was less than the stated volume, and put a + sign beside the difference if the measured volume was greater than the volume stated.

Observations

Brand Name	Measured Volume	Difference from Volume Stated



Conclusions

3. Are there any drink brands that you would not buy because they are not giving the stated volume? Are there any that gave more?

_____

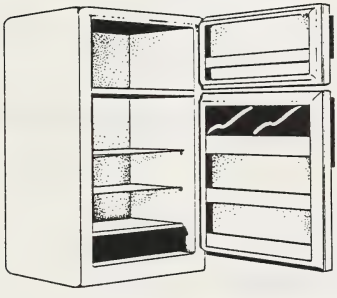
_____

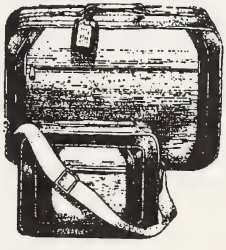
4. As a consumer, is it important that you be able to measure and compare stated volumes with measured volumes? Explain.

_____

_____

You have measured the volume of various containers by measuring the amount of water the containers hold. If you want to find the volume of objects that are not suited to this method you will have to use another method. Some examples of objects of this type are a refrigerator, a suitcase, and a block of wood.

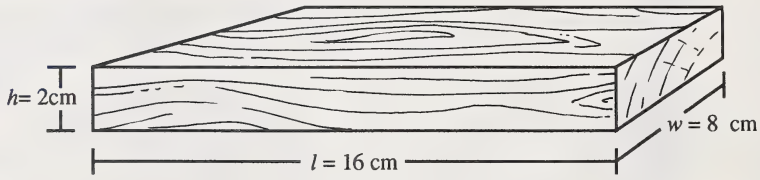




You cannot fill a block of wood with water. The suitcase and refrigerator would also be difficult to fill with water. If you cannot measure the volume of an object by measuring the amount of water it can hold, you might measure the volume using length measurements.

Volume = length × width × height

Work through this example to calculate the volume of a block of wood.



length = 16 cm
width = 8 cm
height = 2 cm

volume = $l \times w \times h$
$V = 16 \text{ cm} \times 8 \text{ cm} \times 2 \text{ cm}$
$V = 256 \text{ cm}^3$

The volume of the block of wood is 256 cubic centimetres. Whenever you see a length measurement raised to the power of three you will know it is a volume unit. For example mm^3, cm^3, m^3, and km^3 are all volume units.

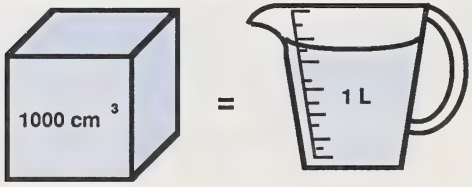
An interesting relationship is found between units of length, volume, and mass in the metric system.

If you make a container that is exactly 10 cm × 10 cm × 10 cm, what is the volume?

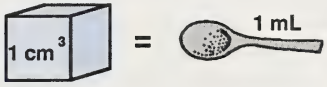
$V = l \times w \times h$
$V = 10 \text{ cm} \times 10 \text{ cm} \times 10 \text{ cm}$
$V = 1000 \text{ cm}^3$

This volume is called a litre (L).

$1000 \text{ cm}^3 = 1 \text{ L}$



Since 1 L = 1000 mL, then 1 cm^3 = 1 mL.



Did you know that 1 teaspoon equals 5 mL?

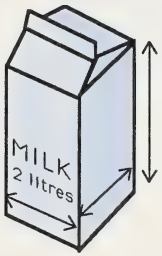
Does a 2 L milk carton actually contain 2 L – that is 2000 cm^3? Does the container have the same volume as what it contains? You can test that out.

5. a. Measure the length, width, and height of a 2 L milk carton. Measure only the straight part as indicated:

length = _____

width = _____

height = _____

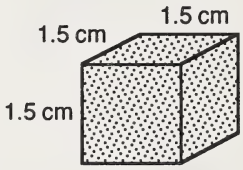


b. Calculate the volume, and compare this volume to the volume printed on the carton. Are the volumes the same?

What other things could you compare this way? Fill the milk container with water, and weigh it on your bathroom scale. What do you think the relationship is between water volume and weight?

If you were to put 15 mL of white sugar into something that you were making and you found only sugar cubes in the house, what would you do? You could take a hammer and crush the sugar so that you could use a measuring spoon. You might estimate the number of cubes needed. But you could also find the volume of a sugar cube by measuring it and using the measurement to figure out how many sugar cubes to add.

6. a. Find the volume of a sugar cube.



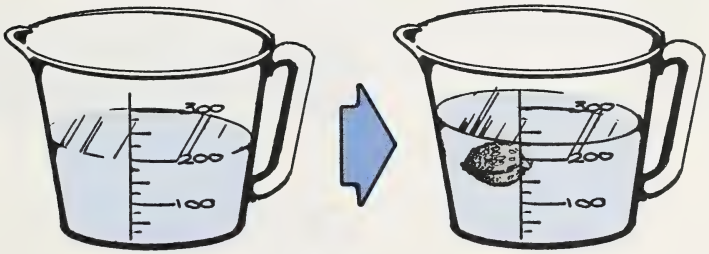
b. How many sugar cubes would be needed if 15 mL of sugar are required?

It is quite easy to find the volume of liquids and the volume of objects with an obvious length, width, and height, but what about the volume of those objects, like a blob of butter, that have no definite length, width, and height? Their volume, too, can be measured with your measuring cups. This is done using a principle called **displacement**.

displacement - the difference between the initial volume and the final volume

An object is placed into a measuring cup that contains enough water so that the object can be completely submerged. The water level in the measuring cup rises as the object is pushed under water. The amount of water that rises when the object is completely under water is equal to the volume of the object. In other words, when the object is submerged it will displace a volume of water equal to its own volume.

After pouring 200 mL of water into a measuring cup, a walnut is placed into the water. If it doesn't sink, it is pushed down with a pencil until it is completely submerged. It is important that the pencil does not enter the water. The final volume of water is 225 mL.



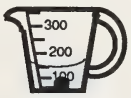
7. How much water is displaced after the walnut is added to the measuring cup?

_____

The walnut is the extra volume.

8. Read each of the measuring cups to determine the volume of the substance or object that has been measured indirectly by displacement.

	Before	After	
a.	volume _____	volume _____	_____ volume of object



b. volume _____ volume _____

_____
volume of object

c. volume _____ volume _____

_____
volume of object

Check your answers by turning to the Appendix, Section 1: Activity 2.

Look at the potato chip bag. The contents in it take up space, but is the measurement given in volume units? Look at the breakfast cereals in your cupboard. How are they measured? The other common unit for measuring the amount of substance is considered next.

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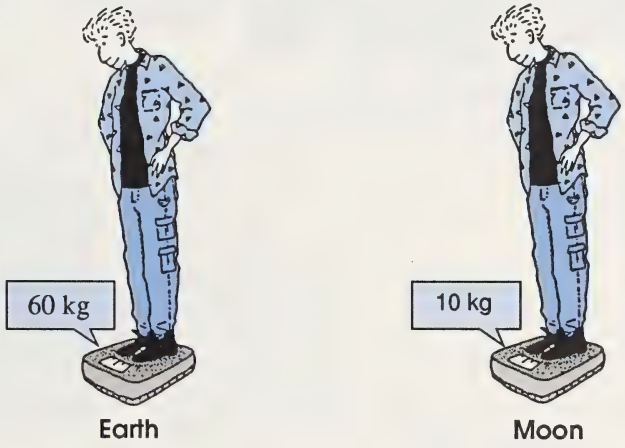
Activity 3: Heavy Stuff

The whole country seems to be preoccupied with weight. Sometimes people think they are too fat or too skinny. What is this thing called weight? Did you know that if you were on the Moon you would weigh only one-sixth of what you weigh on the Earth? How can that be? Would you have shrunk? No. Would you have lost weight? Yes! The reason lies in the definition of weight. The weight of a body is the force the Earth (or Moon) exerts on it.

weight - the force exerted on a body by gravity

compress - to press or squeeze together

Think about the process of weighing yourself on a bathroom scale. You stand on the scale, the Earth pulls you down, and the scale is compressed between you and the floor. This results in a dial moving or some digits being displayed which you read as your weight. Now pretend that you can fly to the Moon and weigh yourself there. You get on the scale, the Moon pulls you down, and the scale is compressed between you and the Moon. The display now reads one-sixth of what it read on the Earth. Why? The Moon has only one-sixth the gravity of the Earth (it is much smaller than the Earth).



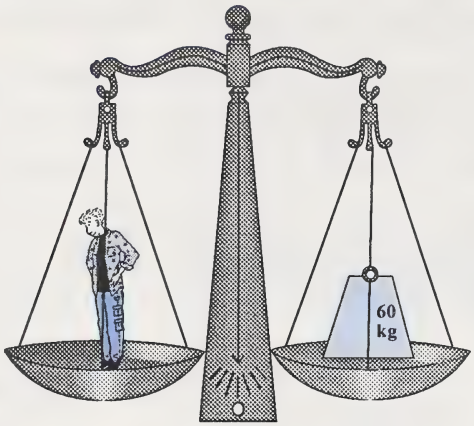
A spring scale measures weight.

Try pushing on the bathroom scale with one hand. The scale indicates with what force you can compress it.

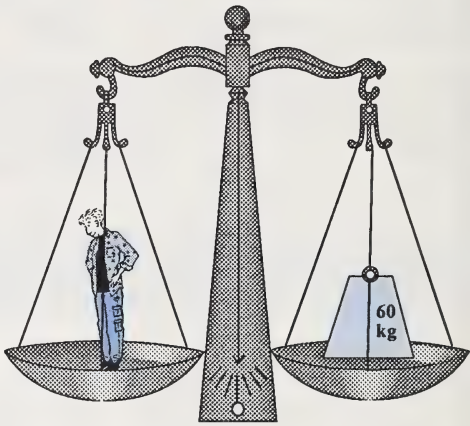
mass - the amount of matter contained within something

Your **mass** does not change when you travel to the Moon. If your mass is 60 kg on the Earth, it is 60 kg on the Moon. But you must use a mass-measuring device to measure mass. A balance beam is just such a device.

A balance beam measures mass.



Earth



Moon

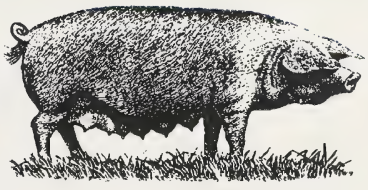
Mass-measuring devices tend to be clumsy since you need to carry the balance and a set of masses. If you wanted to find masses to 100 kg you would have to carry at least 100 kg of masses with your balance. Have you ever bought something where the mass was determined on a balance scale? If not, you might want to go to a hardware store and see how they measure the mass of nails.

Fortunately, weight-measuring devices can be calibrated to find mass (but the device has to stay in the same place; for example, on Earth). Most stores have weight-measuring devices calibrated by a Federal Standards inspector to find mass. Even your bathroom scale gives your mass in kilograms.

The common metric units for mass are

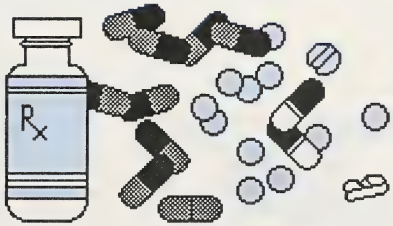
t - tonne
(1000 times larger than kg)

kg - kilogram
(1000 times larger than g)



g - gram
(1000 times smaller than kg)

mg - milligram
(1000 times smaller than g)



Refer to the Appendix, Diagram 1 to see how the mass units relate.

1. a. Look around your house and garage and find ten things that are measured in grams, kilograms, milligrams, or tonnes. Write down the product with the measurement.

_____

_____

_____

_____

_____

_____

_____

_____

_____

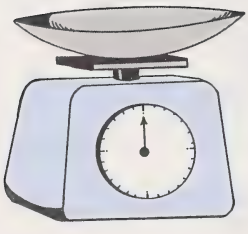
_____

b. What is the most common unit of mass measurement?

_____

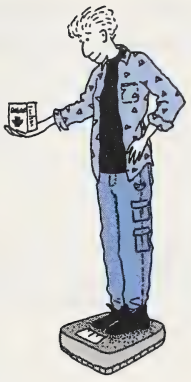
Take three or four different containers that are full of a product and have about the same mass. Are they all the same size? The mass of different things may have different volumes so the containers will probably differ in size.

Now have someone hand you different things of about the same size. Try to guess the mass of each. Can you estimate mass as well as you could estimate volume?



If you have access to a small kitchen-type scale, use it to find the mass of a coffee cup full of different substances like cornflakes, sugar, water, and rice. Do these all have the same mass because they are all the same volume?

If you do not have a kitchen scale you can use a bathroom scale. You should use larger quantities of things to measure this way. Weigh yourself and then take the product to be weighed in your hand and weigh yourself again. Subtract the second value from the first to find the mass of the substance you were holding. Are all the masses the same if they have the same volume?



2. List the substances you measured from the smallest to the largest mass.

_____

_____

_____

_____

3. a. Of the two measurements, volume and mass, which do you think is the most useful? Explain.

_____

_____

b. Which would be easier to use if you wanted to estimate the amount of something?

_____

_____

_____

4. Explain the difference between mass and volume and explain how understanding the difference could be important to you.

_____

_____

_____

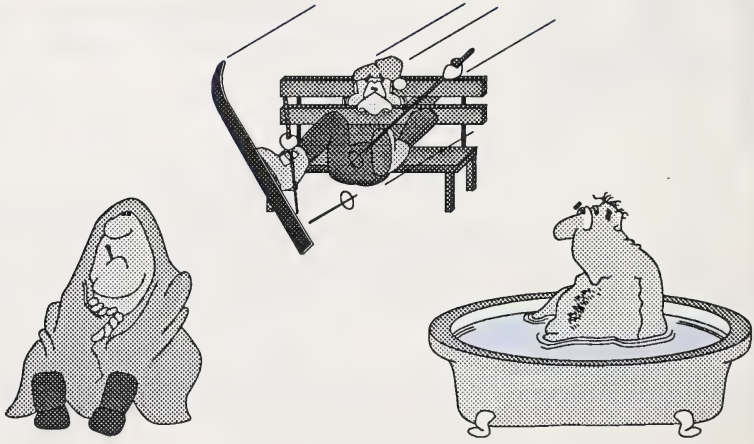
_____

_____

Mass is an important measurement, but you may have found it more difficult to guess mass than volume. That is why you should be extra careful when buying food by mass. A container that looks big may not have very much of the product in it. A wise consumer knows the difference between mass and volume.

Check your answers by turning to the Appendix, Section 1: Activity 3.

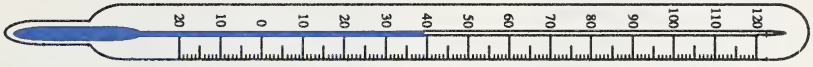
Activity 4: Things Are Heating Up!



Do you look out the window or listen for the temperature on the radio before deciding what to wear in the morning? Do you need to measure the temperature of your bathwater to see if it is hot enough? If you are sick, do you stick a thermometer under your tongue to see if your temperature is over 37°C? When you cook something, do you have to know how hot it is in the oven – if your cookies will bake and not burn?

Many things that you do everyday require that you measure or at least know the temperature of something. The standard unit of temperature is the degree Celsius.

°C – degree Celsius (base unit)

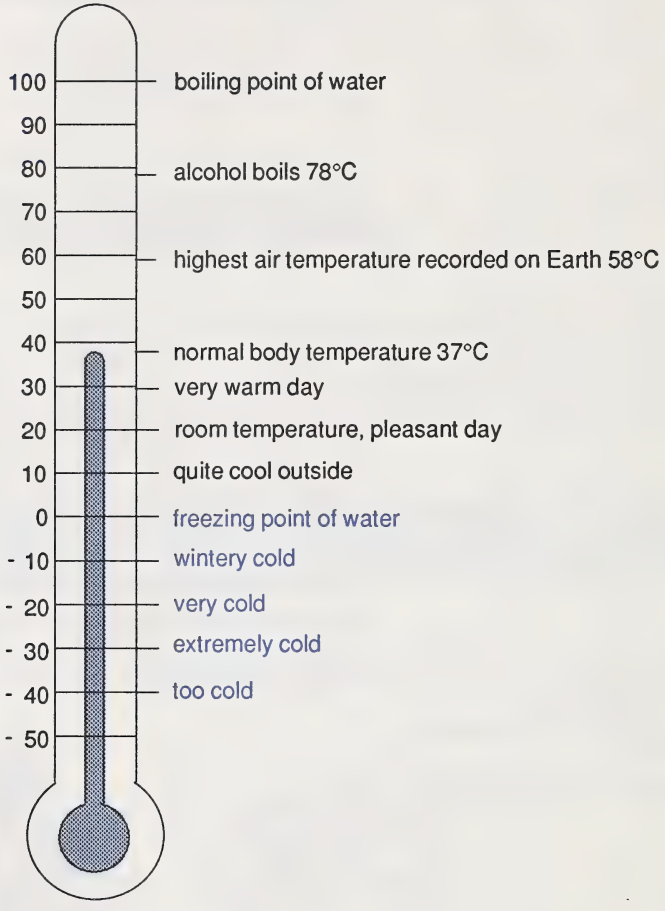


Go around the house and locate any thermometers that you can find. Read the temperature on each thermometer. If they read the same, they are measuring the same temperature. What is the temperature outside? Is it the same as the inside temperature? Usually the outside and inside temperatures are not the same.

If you can find a medical thermometer, make sure you clean it and then take your temperature. Normal body temperature is 37°C. Was your temperature normal? Here are some other temperature normals you can measure using a Celsius thermometer.

thermometer - device for measuring temperature
You use the unit °C for temperature in Canada.

The Celsius Thermometer



1. Give the temperatures for

   a. boiling point of water _____

   b. freezing point of water _____

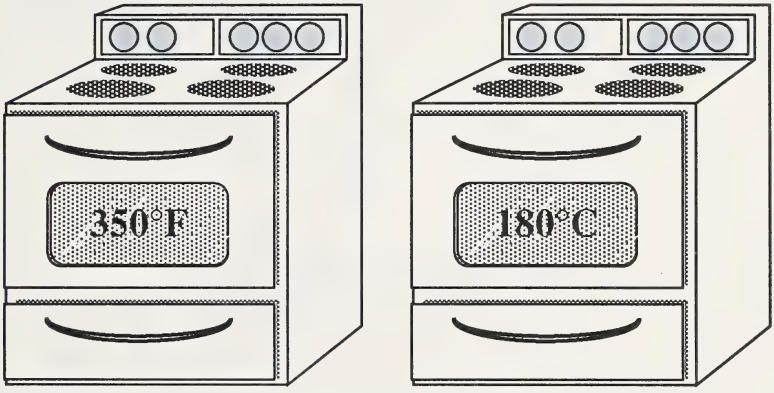
   c. pleasant room temperature _____

   d. your body temperature _____

Fahrenheit - the units for temperature measure in the Imperial System
Freezing point for water is 32°F, and the boiling point is 212°F in this system.

thermostat - a device used for automatically regulating the temperature in an appliance or in the home

What units of temperature does your oven have? Are the units metric (°C) or the old Imperial units (Fahrenheit °F)? The display shows the desired temperature in the oven, but it is not actually measuring the temperature. It has a thermostat that operates to turn the oven on and off keeping the internal temperature constant. If you put a thermometer in an oven while it was operating, it may not read the set temperature. The temperature is constantly changing somewhat higher or lower than the set temperature.



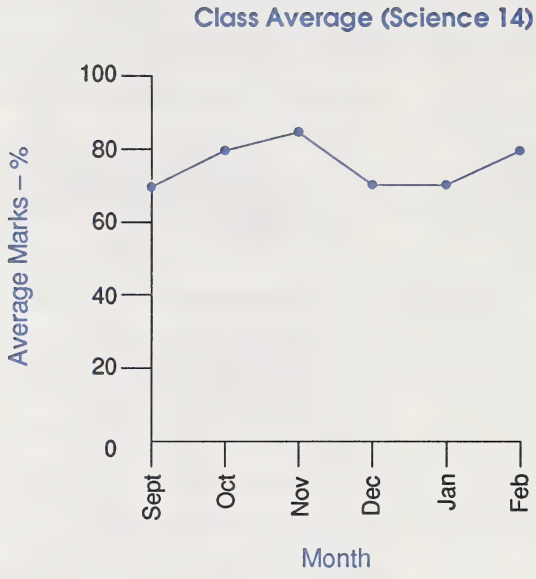
Many stoves today still have the old units for setting the temperature of the oven. Recipes usually have both °C and °F, so either unit can be used.

Graphing

A graph is a good way to show information. Rows of numbers are not easy to interpret. For example, can you find any patterns or trends from the following information?

Month	Class Average (Science 14)
September	70
October	80
November	82
December	71
January	71
February	80

Now look at a graph of the previous data. Can you find any patterns or trends from the graph?



Some of the patterns (trends) that you may have found from the graph are

- the class average increases from September to November
- the class average decreases from November to December
- the class average stays the same from December to January
- the class average increases from January to February

These trends can be found most easily by looking at the graph of the information.

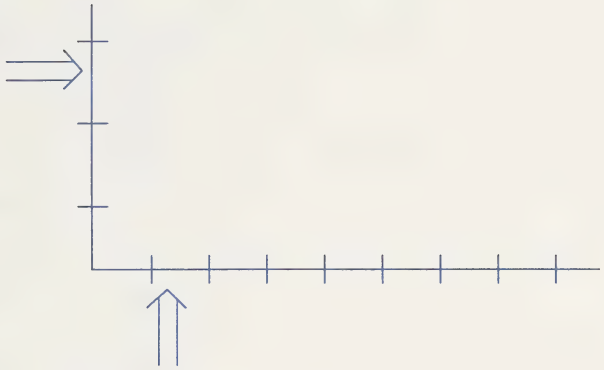
Could the drop in average in December have anything to do with the Christmas season? Or is it due to the cold weather?

There are some rules and definitions that you should know in order to correctly draw graphs.

axes - the horizontal and vertical lines of a graph that give the measures of the information displayed on the graph

The two sides of the graph are called the **axes** (axis - singular).

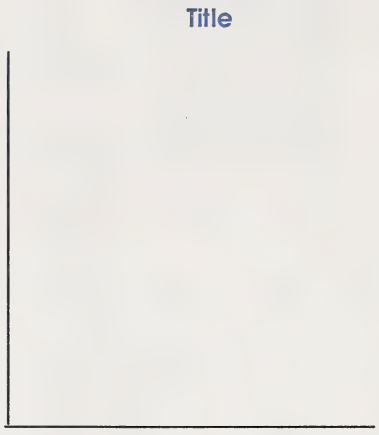
The **vertical axis** is labelled with the measurement and the units. The scale must be evenly spaced.



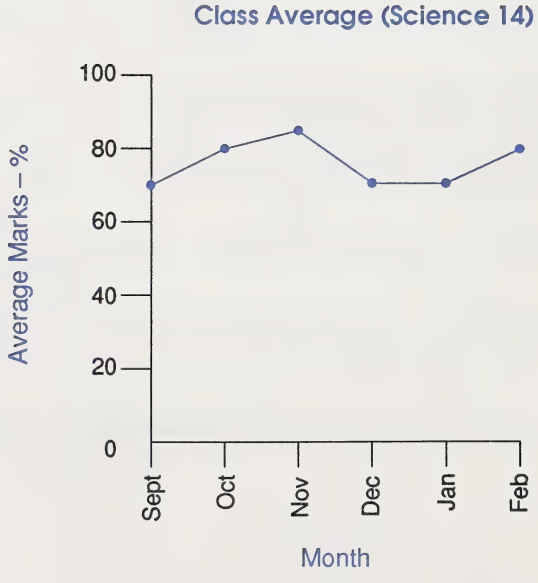
The **horizontal axis** is labelled with the measurement and the units. The scale must be evenly spaced.

The data points are plotted as dots or small circles. These points are connected by straight lines or by a smooth curve through the points.

The graph is given a title which clearly describes what the graph represents.

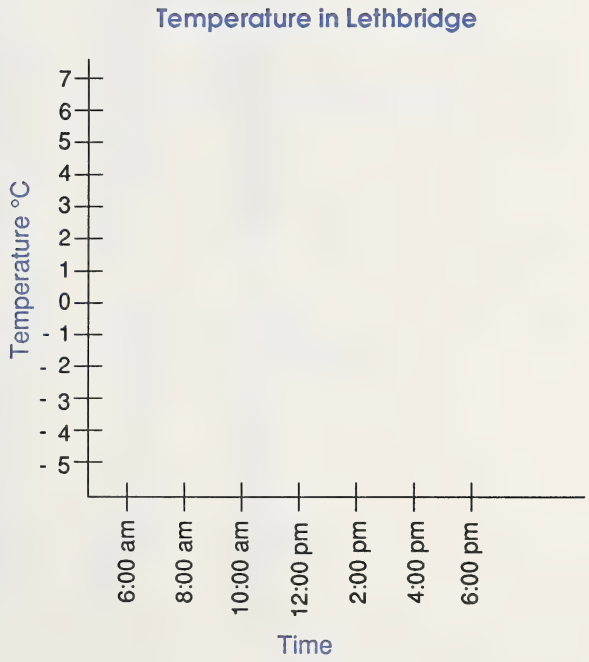


Does this graph follow the rules for correct graphing?



2. a. Now use your knowledge about graphing to make a graph of the following data for the outside temperature in Lethbridge for a 12 hour period.

Time	Temperature
6:00 am	– 4°C
8:00 am	– 2°C
10:00 pm	1°C
12:00 pm	5°C
2:00 pm	6°C
4:00 pm	4°C
6:00 pm	0°C

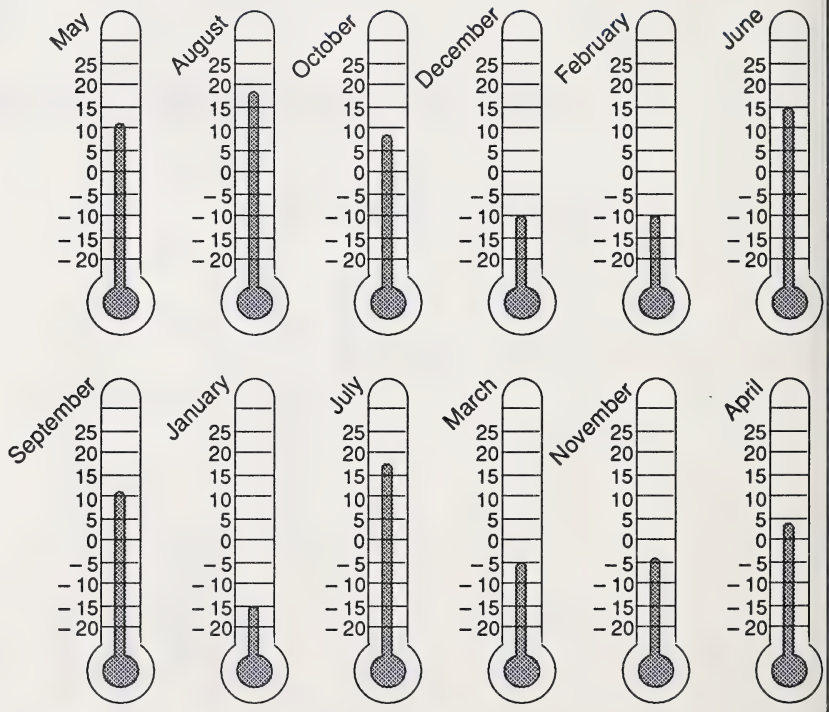


b. What trends do you see from the graph?

The next question requires that you read and organize the information before you draw the graph.

3. a. Read each thermometer and record the temperature beside the corresponding month in the data table.

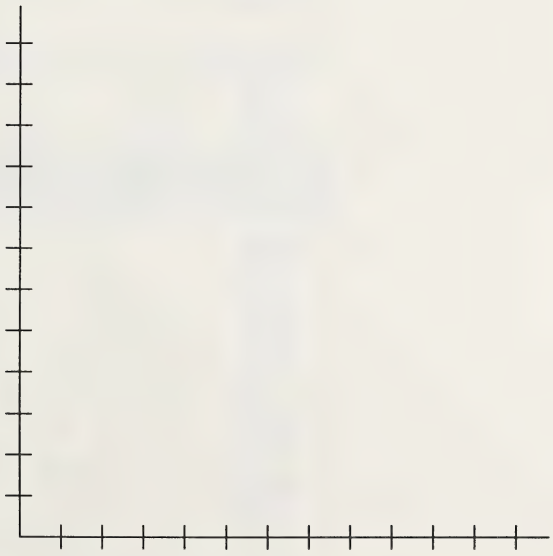
Monthy Average Temperature in Banff, Alberta



Monthly Average Temperature in Banff, Alberta

Month	Temperature (°C)
January	
February	
March	
April	
May	
June	
July	
August	
September	
October	
November	
December	

b. Plot the data from your data table on the following axes. Be sure that your graph is complete and correctly labelled.



c. Describe any trends on patterns that you see over the year for Banff, Alberta.

_____

_____

_____

_____

_____

Check your answers by turning to the Appendix, Section 1: Activity 4.

Follow-up Activities

If you had difficulties understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

Taking measurements and being able to use measuring devices is useful in the home.

The measurements and units which you have examined are

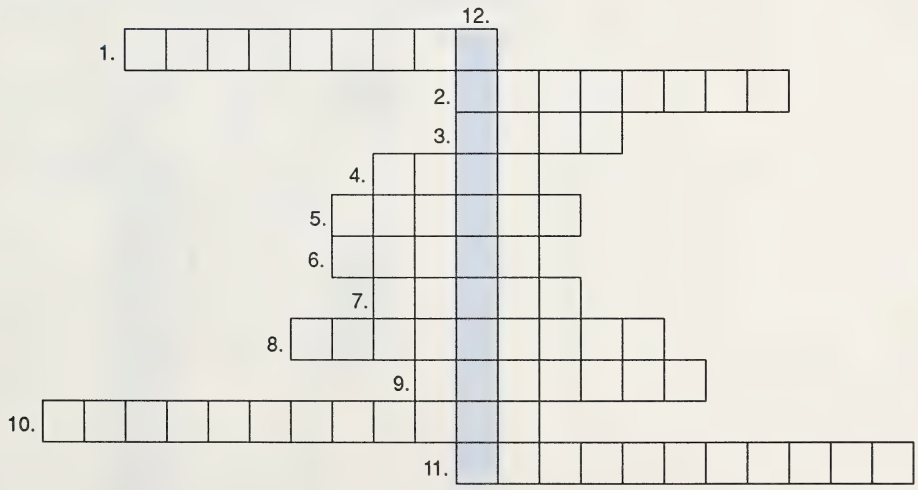
Measurements	Units	Examples
length	km	road lengths
	m	your height, track and field
	cm	paper, board widths
	mm	pins, nails
area	m^2	rooms, carpet
$A = l \times w$	cm^2	boxes, cartons
	km^2	yards, fields

Measurements	Units	Examples
volume $V = l \times w \times h$ $1000\ cm^3 = 1L$ $1\ cm^3 = 1\ mL$	mL L cm^3 m^3	toothpaste, shampoo, pop milk, gasoline solid volumes fridges, rooms
mass (scale or balance)	t kg g mg	truck loads (grain, gravel, soil) food, meat vegetables, bulk foods, snack foods pills, vitamins
temperature	°C	oven temperatures, outside temperature

Graphs may be used to organize and present information in a way that is easier to understand and interpret.

acrostic - a composition in which letters taken in order form a word

Complete the acrostic that deals with units and measurements in the household. Find the hidden word when all the other words are complete.



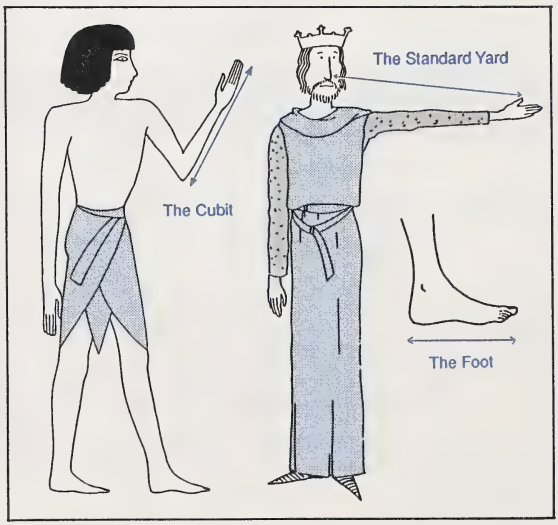
1. measurement of mass
2. an inaccurate measurement
3. the measurement of length × width
4. how heavy you are
5. how much space something occupies
6. the measurement for milk and pop
7. an estimation
8. measurement of road distances
9. temperature measurement
10. finding the volume of irregular-shaped objects
11. used to find the temperature of something
12. **Hidden Word** _____

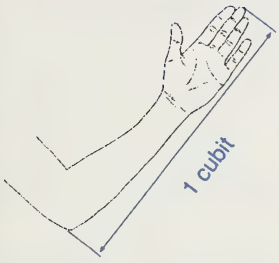
Check your answers by turning to the Appendix, Section 1: Extra Help.

Enrichment

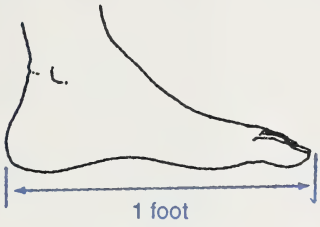
History of Measurement

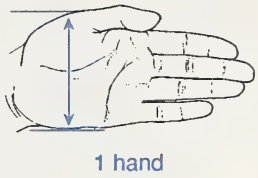
Even though the measurement techniques and devices that you use today are the same for everyone, this was not the way that measurement started out. When people first decided to build they needed a way to measure their materials. The answer was to use their bodies as the measuring tools. Not only did the hand become a useful measuring device, but later the width of the thumb and foot were common units of measurement as well.

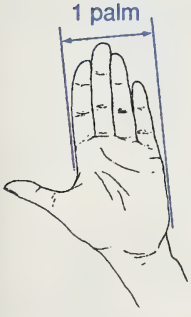




The problem was solved. Soon everyone was using their feet and arms to measure materials for buying, selling, and building.







Using body units, measure the length of three things in the room; example: the length of the room, the height of a chair, the length of this page. Record your measurements to the nearest half a unit in the space provided.

_____

_____

_____

Now have someone else measure the same three things. Make sure the other person uses the same units that you used to measure the objects.

_____

_____

_____

1. a. Were the measurements you recorded the same as the measurements the other person recorded? If not, why were they different?

_____

_____

_____

b. Is using this technique for measurement reliable? Tell why or why not.

_____

_____

c. Give reasons why this way of measuring caused problems for the people who used it to buy and sell products.

_____

_____

Check your answers by turning to the Appendix, Section 1: Enrichment.

Conclusion

Measurement helps you describe things. It gives you an idea of distance, volume, mass, and temperature. Products sold in Canadian grocery stores must contain information on the label that informs you about the quantity of goods you are receiving. You may be deceived by the size of a bag or box, but as an informed shopper you should check on the mass or volume of the contents rather than the size of the container. Being an informed consumer can help you make wise decisions concerning the products that appear in the marketplace. Being informed about measurement around the home will make many of the everyday household processes much easier and understandable. Knowing how to measure will help you survive in the kitchen, garage, at the store, in school, and later on the job.

ASSIGNMENT

Turn to your Assignment Booklet and do the assignment for Section 1.

2 Mixing It Up

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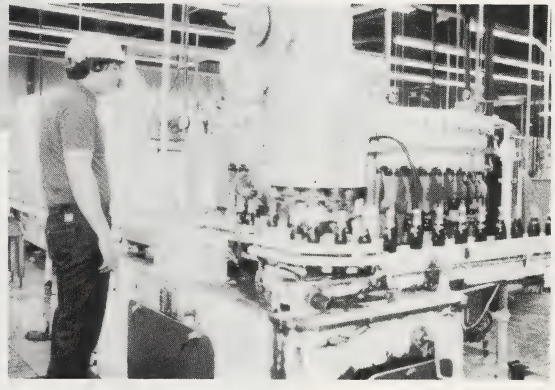

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You pour salt into boiling water before cooking spaghetti. Oil and gasoline may be mixed for use in a snowmobile engine. Take a drink of carbonated soda pop. Where does the fizz come from? You may have tried to mix oil and water in a salad dressing only to discover that not all substances can be dissolved. Each of these descriptions is an example of mixing things up to make a useful product. When you have finished Section 2 you will have considered solutions and the substances that make up solutions.

Activity 1: Mixtures

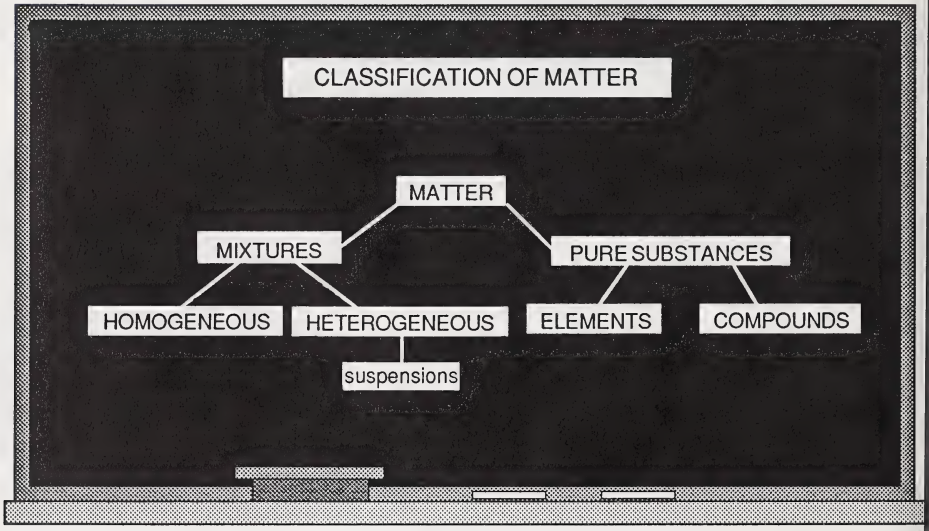
matter - anything that has mass and takes up space

classify - to arrange or put into an organized manner

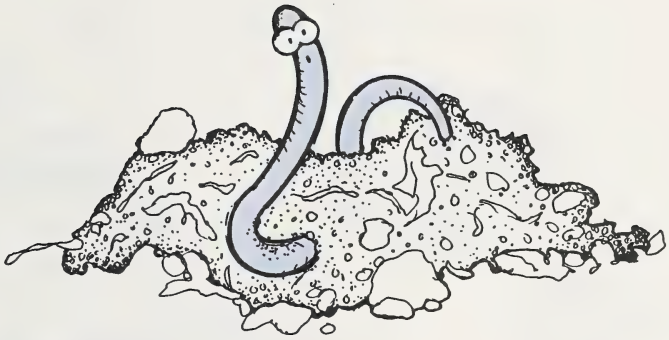
classification tree - an orderly arrangement of classes listed from general to specific

Look around you. What do you see? You probably see this page, the table, the walls, and other people around you. All the objects that you see are made of substances called **matter**. Matter is everything. You are made of matter. The chair you sit on and the floor that the chair sits on is matter. Even the air that you breathe is matter. Since matter is everything around you, it would be very hard for you or anyone to study all of it. To make learning about science easier, scientists **classify** things. Classification is a part of science that organizes things, breaking big sections into smaller, easier-to-handle sections. To study matter you will first see how it can be classified and then study some aspects of matter.

The following is a **classification tree** for all matter.



Mixtures



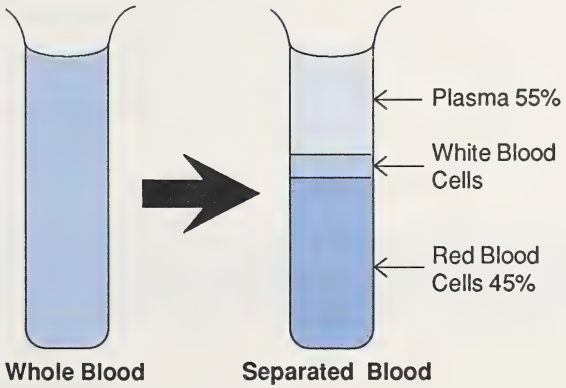
mixture - two or more substances that are blended together but not joined
The parts of a mixture can be separated out.

Soil is a **mixture**. In it you can see different parts such as sand, dirt, bits of leaves, and maybe even some small pebbles. Blood is also a mixture, but it is not classified the same as soil. There are separate parts, but you can't see them. Do you know what the parts of blood are? The Red Cross often separates blood into parts for storage and use at different times and by different people. They do this by spinning the blood around at very high speeds. Soil can also be separated into parts. Can you figure out how?

heterogeneous - varies in properties and composition from one part to another

Soil and other mixtures like it are called **heterogeneous** mixtures because you can see the separate parts. Blood and other mixtures where you can't see the separate parts are called **homogeneous** mixtures.

homogeneous - having the same properties and composition throughout



Here are some more examples of other mixtures:

1. List the homogeneous mixtures in the diagram.

_____

_____

_____

2. List the heterogeneous mixtures in the diagram.

_____

_____

_____

Mixtures can be separated by physical processes like filtering, evaporation, shaking, settling out parts, picking out the distinct parts, as well as by other ways.

3. a. How would you separate a mixture of sand, salt, and water?

_____

_____

_____

b. How could you separate out the parts in a serving of lettuce, carrots, and mushrooms?

_____

_____

_____

Check your answers by turning to the Appendix, Section 2: Activity 1.

Activity 2: Pure Substances

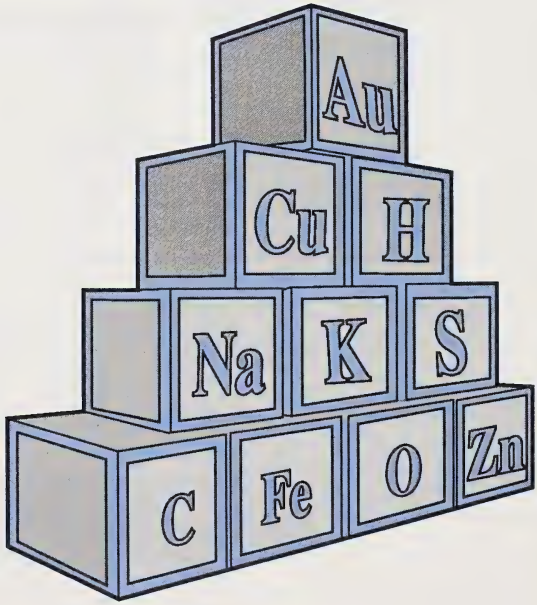
Is everything around you a mixture? Certainly not. The aluminum pot on the stove and the aluminum pop can are made of pure aluminum. The sugar you put in your coffee, tea, or baking is pure sugar. If you try to separate the sugar or aluminum into different substances (like you did with mixtures) you would find that the separation cannot be done. You will always end up with only the sugar or the aluminum. Substances which contain only one type of substance are called **pure substances**.

pure substance- a substance which contains only one element or compound

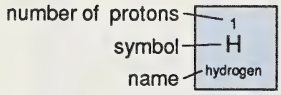
Scientists have always searched for the basic building blocks of matter. The smallest materials which still have characteristics of everyday matter are called the **elements**. While one elementary particle can today be split into smaller particles, these particles are not in the form of everyday matter. All of the elements discovered to date are organized into the **Periodic Table of Elements**. On the next page is a copy of the periodic table.

element - a substance which cannot be split into a simpler form

Periodic Table of Elements - an arrangement of all the elements in order of atomic number



Periodic Table of Elements



1 H hydrogen																2 He helium
3 Li lithium	4 Be beryllium											5 B boron	6 C carbon	7 N nitrogen	8 O oxygen	09 F fluorine	10 Ne neon
11 Na sodium	12 Mg magnesium											13 Al aluminum	14 Si silicon	15 P phosphorus	16 S sulfur	17 Cl chlorine	18 Ar argon
19 K potassium	20 Ca calcium	21 Sc scandium	22 Ti titanium	23 V vanadium	24 Cr chromium	25 Mn manganese	26 Fe iron	27 Co cobalt	28 Ni nickel	29 Cu copper	30 Zn zinc	31 Ga gallium	32 Ge germanium	33 As arsenic	34 Se selenium	35 Br bromine	36 Kr krypton
37 Rb rubidium	38 Sr strontium	39 Y yttrium	40 Zr zirconium	41 Nb niobium	42 Mo molybdenum	43 Tc technetium	44 Ru ruthenium	45 Rh rhodium	46 Pd palladium	47 Ag silver	48 Cd cadmium	49 In indium	50 Sn tin	51 Sb antimony	52 Te tellurium	53 I iodine	54 Xe xenon
55 Cs cesium	56 Ba barium	71 Lu lutetium	72 Hf hafnium	73 Ta tantalum	74 W tungsten	75 Re rhenium	76 Os osmium	77 Ir iridium	78 Pt platinum	79 Au gold	80 Hg mercury	81 Tl thallium	82 Pb lead	83 Bi bismuth	84 Po polonium	85 At astatine	86 Rn radon
87 Fr francium	88 Ra radium	103 *Lr* lawrencium															

57 La lanthanum	58 Ce cerium	59 Pr praseodymium	60 Nd neodymium	61 *Pm* promethium	62 Sm samarium	63 Eu europpium	64 Gd gadolinium	65 Tb terbium	66 Dy dysprosium	67 Ho holmium	68 Er erbium	69 Tm thulium	70 Yb ytterbium
89 Ac actinium	90 Th thorium	91 Pa protactinium	92 U uranium	93 *Np* neptunium	94 *Pu* plutonium	95 *Am* americium	96 *Cm* curium	97 *Bk* berkelium	98 *Cf* californium	99 *Es* einsteinium	100 *Fm* fermium	101 *Md* mendelevium	102 *No* nobelium

Each element has been named and given a symbol. The names and symbols are the same in all languages so that scientists around the world can communicate.

1. Use the periodic table to write the symbol for each of the following elements.

   a. copper _____
   b. oxygen _____
   c. carbon _____
   d. lead _____
   e. calcium _____

Many of the elements listed in the periodic table are found in nature. There are some elements which are synthetically prepared. The synthetically produced elements are made in special laboratories and nuclear facilities. The **synthetic** elements usually have a very short life span before they break down into other more stable elements.

synthetic - not naturally occurring; man-made

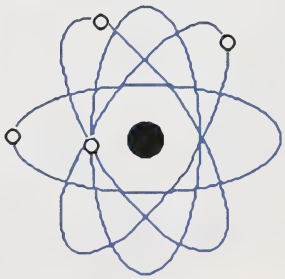
2. Write the name and symbols of two synthetic elements. The symbols for the synthetic elements are written in slanted letters on the periodic table.

_____

_____

atom - the smallest particles that make up matter

The simplest part of an element is called an **atom**. You probably have seen a representation of an atom which looks something like this.



The picture represents electrons orbiting a dense central nucleus. How many elements are there? The periodic table has 103 elements. Are there more elements to be found or have they all been found?

compound - two or more elements chemically joined together

molecules - particles made from two or more atoms joined together

There are many pure substances which are not elements. Is sugar an element? You can search through the entire periodic table and you will not find sugar. That is because sugar is a **compound** not an element. The atoms of three elements; carbon, oxygen, and hydrogen, are bonded together into **molecules**.

You have probably seen labels such as "pure orange juice," "pure corn oil," and "100% wheat flour." From the discussion of pure substances, you know that orange juice is not an element or a single compound. Orange juice is a mixture of water, fruit particles, and many other elements and compounds. The reason it is labelled as "pure" is because it contains only orange juice, not lemon juice or any other fruit juice.

Is anything in your house a pure substance? Technically the answer is no. Everything has a certain amount of impurity, but some things contain such a large percentage of only one element or compound that they are called pure substances. Table salt is such an example. The majority of table salt is a compound – sodium chloride. There are probably many other substances in table salt such as iodine and magnesium salts.

When you are asked to classify a substance as a mixture or a pure substance think about the composition of the substance carefully. Take gasoline for example. Is gasoline a single compound or is it a mixture of various compounds? You should know that oil companies "blend" gasoline. In other words, they mix various compounds together to make gasoline; therefore gasoline is a mixture not a pure substance. In the case of salt, you could classify it as a pure substance since the vast majority of table salt is sodium chloride.

The pure substances shown in the diagram are compounds not elements.

3. a. From the following list of pure substances, decide which are elements and which are compounds, and put them in the correct column.

   Hint: Compounds will not be found on the periodic table of elements.

   - carbon dioxide
   - water
   - chalk
   - iron
   - silver
   - gold
   - alcohol
   - mercury

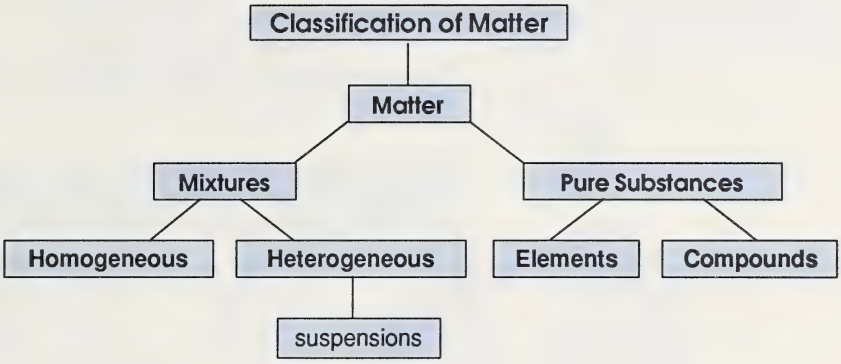
Elements	Compounds

b. Add to this list by thinking of some other things around your house that may be either an element or a compound.

Elements	Compounds

Check your answers by turning to the Appendix, Section 2: Activity 2.

Here is the classification tree again. You should be familiar with most of the words on it now. You may want to refer back to this classification while working through the rest of the section because you will learn more about each group in the following activities.



Activity 3: Solutions

It's magic! Stir sugar into a glass of water and it disappears without a trace. But is it actually gone? How could you test to see if the sugar had really disappeared? What you have made is a **solution**. This is a special kind of mixture where the particles are so small and evenly distributed in the water that they cannot be seen. Solutions are clear – if they are light coloured you can see right through them.

solution - a mixture of materials that do not separate when left standing

solute - the part that dissolves in a solution

solvent - the part of a solution that dissolves the solute

The more common solutions consist of a solid dissolved in a liquid, like the water-sugar combination, or of a liquid dissolved in a liquid, like dish detergent in water. All solutions consist of two parts: the **solute**, or dissolved substance, and the **solvent**, or dissolving substance. For example, in a sugar-water solution, sugar is the solute and water is the solvent. The substances dissolve in one another. The solute is what seems to disappear in the solvent.

The following table gives some examples of common solutions that you may have encountered.

Solute	Solvent	Solution
gas	gas	deep-sea diver's gas (oxygen-helium)
gas	liquid	soda pop (carbon dioxide in water)
liquid	liquid	antifreeze and water
solid	liquid	sugar in water

alloy - a solution of metals

All other combinations of states are possible but are usually given special names. For example, a solid-solid solution is usually called an **alloy** (gold-silver in a ring).

1. Identify the solute and solvent for each of the following solutions.

a.

Coffee

b.

c.

Air
Humidity 50%

Solution	Solute	Solvent
a.		
b.		
c.		

Water

Water is a special solvent because it will dissolve so many things. Nearly everything you drink is some kind of a solution with water as the solvent. Even the food you eat must be broken down into a solution so that it can be carried in the blood (which is also a water solution) to the cells of your body. Water is called the universal solvent because it is very common and so many things can be dissolved in it.

If water was a universal solvent, what kind of container would you need to carry it in?

In the following investigation you will examine some of the properties of water as a solvent with various solutes.

Investigation: Water – A Universal Solvent?

If you get a stain on your shirt you may reach for some water to try to remove the spot. You knew even before reading this that water is a good solvent and may dissolve the stain so it can be rinsed away.

In this investigation you will examine water as a solvent with different household solutes in order to identify substances that can be dissolved in water. You will also answer the question: Do all substances dissolve in water?

Materials You Need

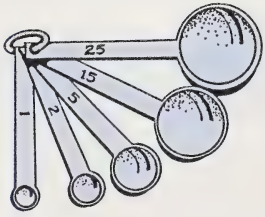
- measuring spoons
- test tube
- rubber stopper
- baking soda
- powdered soap
- rubbing alcohol (or methyl hydrate)
- turpentine (or paint thinner)
- sugar
- flour
- butter
- cooking oil
- salt
- vinegar
- soil
- cornstarch
- drink crystals
- instant coffee

Steps to Follow

Complete the table of observations as you do the investigation.

STEP A

Use a dry measuring spoon or a graduated cylinder to add 2 mL of sugar to a clean and dry test tube.



STEP B

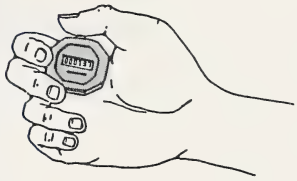
Measure 10 mL of water with the graduated cylinder or a measuring spoon and add it to the test tube with the sugar in it.

STEP C

Place the stopper in the test tube and shake the test tube vigorously for 1 minute. Record your observations in the table.

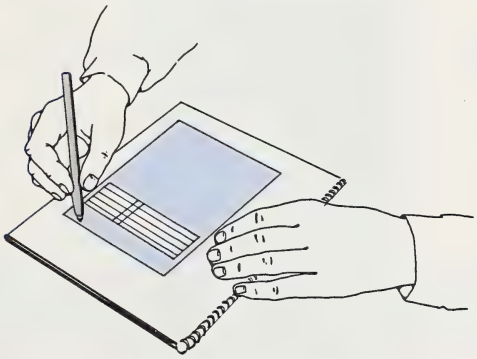
STEP D

Allow the test tube to sit for 2 minutes and look for any changes. Record your observations in the table.



STEP E

Wash and dry the test tube between tests. Repeat the first four steps for each of the other substances to be tested. Remember to record your observations in the following table.



Observations

Substance Tested	Observations After Shaking for 1 Minute	Observations After Waiting for 2 Minutes
sugar		
salt		
cooking oil		
powdered soap		
flour		
butter		
baking soda		
rubbing alcohol		
turpentine		
vinegar		
cornstarch		
instant coffee crystals		
drink crystals		

Conclusion

2. a. Do all substances dissolve in water? That is, do all of the substances form water solutions? Explain using examples.

_____

_____

_____

_____

b. Are solutions clear or cloudy mixtures?

_____

_____

3. Do the substances that dissolve in water dissolve in turpentine or alcohol?

_____

_____

4. Try to give a reason why different solutes dissolve in different solvents.

_____

_____

_____

Check your answers by turning to the Appendix, Section 2: Activity 3.

Follow-up Activities

If you had difficulties understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

In Section 2 you learned that all matter can be classified into groups.

- mixtures – substances blended but not joined; the parts do not necessarily dissolve
- solutions – mixtures where the solute (part that dissolves) dissolves completely in the solvent (part that does the dissolving); solutions are clear
- pure substances – cannot be separated into parts and can be either elements (one kind of atom) or compounds (two or more elements chemically bound together)

Water is a special solvent because it dissolves so many things, but there are some things that water cannot dissolve. Water is said to be selective because it can dissolve only certain solutes.

Complete the sentences with the correct word or words to review concepts about solutions.

1. Matter that has only one kind of atom is called an _____.
2. Matter that has two or more different kinds of atoms chemically bonded together is called a _____.
3. Two or more different things blended together but not joined chemically are called a _____.
4. A solution has _____ main parts.
5. The dissolved part of a solution is called the _____.

6. The part that does the dissolving in a solution is the _____.

7. The most common solvent is _____, and therefore it is sometimes called the _____ solvent.

8. Solvents only dissolve certain things. This means solvents are _____.

9. _____ is what makes up everything around you.

10. Oil and water would be called a _____ mixture because you can see separate parts, and salt water would be called a _____ mixture because no parts are visible.

11. Scientists organize information into groups. They _____ matter into pure substances and mixtures.

12. One such organization is called the Periodic Table, which organizes all the _____ into a table.

Check your answers by turning to the Appendix, Section 2: Extra Help.

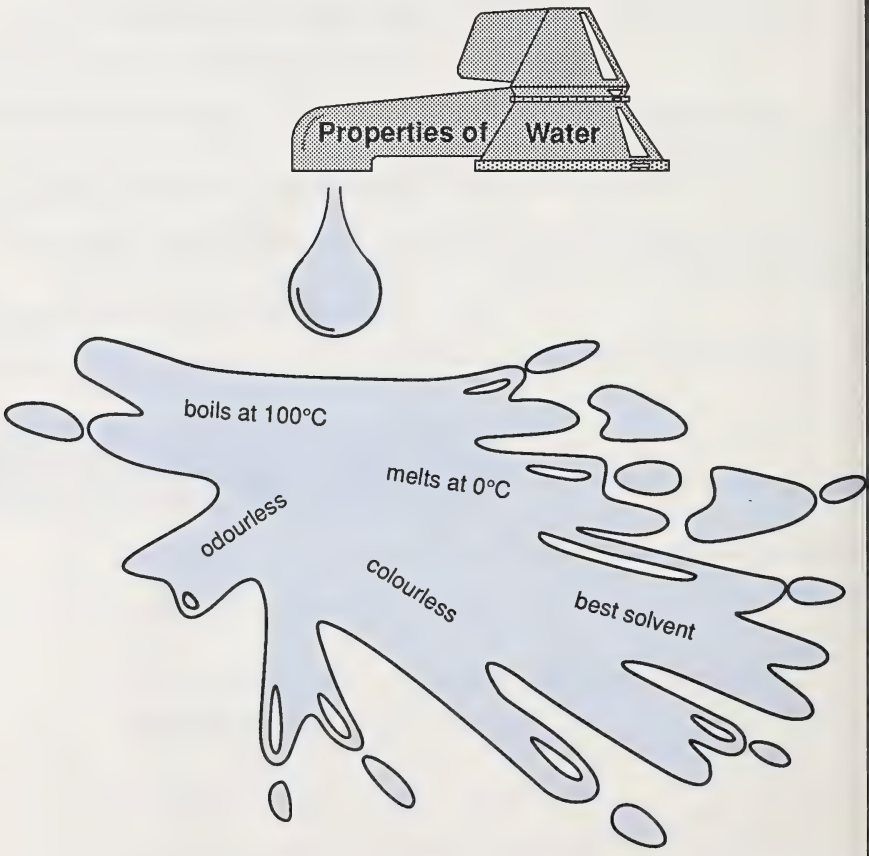
Enrichment

Changing Water

Could you imagine living a day, a week, or a month without water? It isn't possible to survive very long without water.

As you have learned in this section on mixtures, water is an important substance that is very necessary to your life. You use it to cook with and bathe in; and it is in your food, drink, and even your own body. It is one of the most common substances on Earth.

Water has its own way of behaving. It has very distinctive characteristics and properties.



Is water the same even when it has things dissolved in it? If you want to find out, the following investigation will give you some idea of how substances dissolved in water affect the properties of water.

Investigation: Properties of Water in Solutions

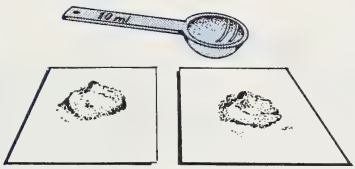
Materials You Need

- sugar
- salt
- two polystyrene cups
- two stirrers (glass or wooden)
- grease pencil or masking tape
- 1 beaker or pan to boil water
- stove or hotplate
- thermometer
- measuring spoons, graduated cylinder, or balance
- container of crushed ice and ice water

Steps to Follow

STEP A

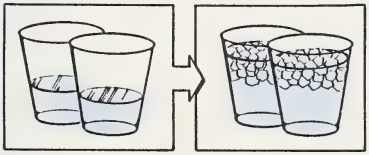
Put 10 mL (2 teaspoons) of sugar and 10 mL of salt on separate pieces of paper. Make sure you label each sample.



STEP B

Fill each of the cups half full of ice cold water and then add ice almost to the top of the cup.

*



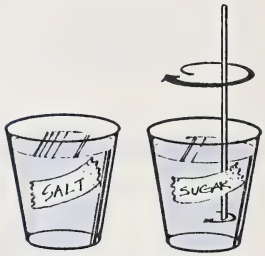
*Note: Clear glasses are used in the diagrams so that you can see the lab procedure. You should use polystyrene cups, which are not clear, to get the best results.

STEP C

Place the thermometer in the ice water for 5 minutes; then use the thermometer to measure the water temperature in each cup. Do not go on to step D until the temperature in both cups is the same. Record this temperature in the step E observation box. This is the freezing point of water.

STEP D

Label the cups *sugar* and *salt*. Pour 10 mL of sugar in the sugar cup and 10 mL of salt in the salt cup. Stir each cup well to dissolve the sugar and salt into the water.



STEP E

Measure the temperature of each solution and record the temperatures in the table. Clean the thermometer off between measurements.

OBSERVATION

Freezing Point of Water	
Salt Solution Temperature	
Sugar Solution Temperature	

1. What happens to the freezing point of water when a solute is dissolved in the water?

_____

_____

_____

STEP F

Add 20 mL more sugar to the sugar cup, stir well, and measure the temperature.

OBSERVATION

2. Does the addition of more sugar particles to the solution lower the freezing point?

_____

STEP G

Use the stove or hotplate to bring a pot containing about 100 mL of water to a boil. Measure the temperature of the water when it is boiling and record it in the table in Step H.

STEP H

Add 15 mL of salt to the boiling water. Heat and stir until the solution is boiling. Use the thermometer to measure the boiling point of the solution.

OBSERVATION

Boiling Point of Water	
Boiling Point of Salt Water	

3. What happens to the boiling point of water when salt is dissolved in the water?

_____

_____

Conclusions

4. What do you predict would happen to the freezing point of water if any type of solute is dissolved in it?

_____

5. Based upon what you have learned about the change in the properties of water when solutes are added, what is the benefit of adding antifreeze to the cooling system of a car in winter?

_____

_____

6. What do you predict would happen to the boiling point of water if any type of solute is dissolved in the water?

_____

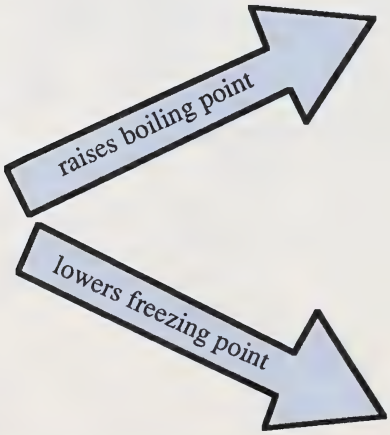
7. How does the addition of antifreeze to the cooling system of a car help in the summer time?

_____

_____

_____

Adding certain solutes to water changes the properties of water.



Check your answers by turning to the Appendix, Section 2: Enrichment.

Conclusion

Mixtures are a part of your everyday life. Some things dissolve well in water to make solutions that you can use. Some substances dissolve in solvents other than water. You should now be able to identify the different parts of a solution and distinguish mixtures and solutions from pure substances. You should now be able to appreciate the importance of solutions in many things that you do.

ASSIGNMENT

Turn to your Assignment Booklet and do the assignment for Section 2.

3 Solubility

If your vehicle leaks oil on the ground and it rains, does the oil get washed away? Can the water dissolve the oil and carry it away? When you are in the kitchen and want to make juice, do you notice that the sugar you add doesn't dissolve very fast and there may be some of it left undissolved when you get to the bottom of the jug?

As you do the activities in this section you will discover ways to make things dissolve faster and learn how to make solutions that have a large amount of solute dissolved in them.

Activity 1: Will It Dissolve?

solubility - the ability of a substance to dissolve in a solvent

insoluble - when a substance will not dissolve in a solvent

soluble - able to dissolve

In Section 2 you discovered that some things easily dissolve in water while others do not. The measure of how well solutes dissolve in their solvents is called **solubility**. Oil and water do not dissolve in each other. They are said to be **insoluble**. If solutes dissolve well in a solvent they are called **soluble**. Many things are soluble in water.

1. a. Name two substances which are insoluble in water.

_____

_____

b. Name two substances which are soluble in water.

_____

_____

There are a number of factors that affect how well or how fast something will dissolve. Some of these are

- type of solute and solvent
- temperature of the solvent
- size of the solute particle
- stirring or not

Investigation: Solutions and Dissolving – Other Solvents

Remember that stain on your shirt? You tried using water to remove the spot but it didn't work. The stain may be one that is insoluble in water. What do you do next? Maybe you try a squirt of liquid soap. After a little scrubbing, rinse the stain and soap out with cold water and the stain disappears. The soap is a solvent which is able to mix with the stain and dissolve it.

In this investigation you will examine solvents other than water and use household solutes to test the solubility of different solute-solvent combinations.

Caution: Many strong solvents can be very harmful if they get in your eyes, mouth, or on your skin. Read the labels carefully.

Materials You Need

- graduated cylinder or measuring spoons
- test tube
- rubbing alcohol
- rubber stopper
- salt
- water
- butter
- sugar
- powdered soap
- cooking oil
- turpentine (paint thinner)
- other solvents and solutes of your choice

Steps to Follow

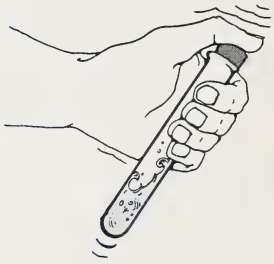
Read through steps A - G before beginning the investigation. Record your observations in the table as you do the investigation.

STEP A

Mix 2 mL of solute with 10 mL of solvent in a clean test tube. Combine the substances listed in the observation table.

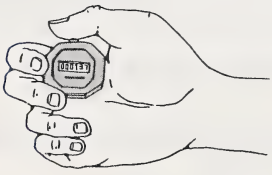
STEP B

Cork the test tube and shake gently for 1 minute. Record your observations.



STEP C

Allow the test tube to sit for 2 minutes and check for any change. Record your observations in the table provided.

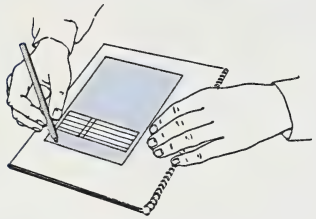


STEP D

Wash and dry the test tubes and measuring spoons.

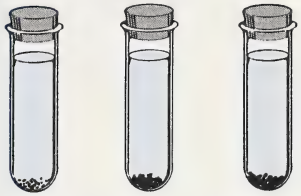
STEP E

Repeat the first four steps for each of the other substances listed in the observation table. Remember to enter observations in the table.



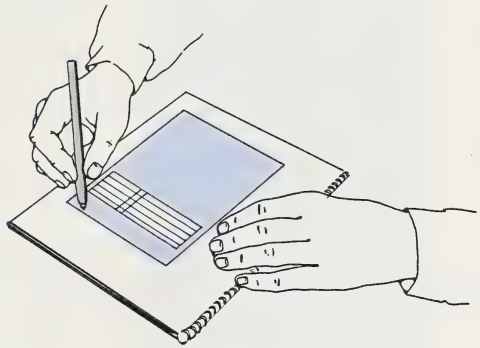
STEP F

Choose at least three other combinations of solvents and solutes from your house.



STEP G

Write down your choices on the table, perform the solubility test for each, and record your observations.



Observations

Substances to Be Mixed solute – solvent	Observations After Shaking for 1 Minute	Observations After Waiting for 2 Minutes
oil – water		
oil – turpentine		
butter – water		
butter – turpentine		
sugar – water		
sugar – rubbing alcohol		
salt – rubbing alcohol		
salt – water		
powdered soap – water		
powdered soap – turpentine		
Your Choices		

Check your answers by turning to the Appendix, Section 3: Activity 1.

Conclusions

2. Classify the substances you tested as soluble or insoluble in water. Write the names of the substances in the appropriate columns.

Soluble	Insoluble

3. Were the substances that were insoluble in water soluble in other solvents? Use examples, to explain your answer.

4. Using what you learned from this investigation, explain why soap and water cleans oil-stained clothes better than water alone.

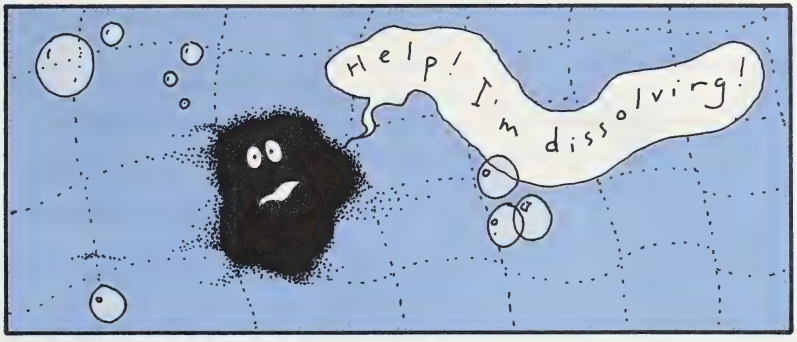
selective - has the ability to dissolve only a certain kind of substance

Although water is a good solvent, it does not dissolve everything. Solvents are selective in that they will only dissolve certain solutes. There are many solvents for dissolving many different types of solutes that cannot be dissolved by water.

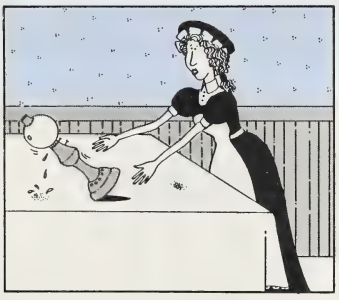
5. For each of the pictured examples try to predict what solute the solvent is dissolving.

Picture	Solvent	Solute
a. nail polish remover	trichloroethane	
b. suntan lotion	alcohol	
c. iodine solution	alcohol	
d. car wax	turpentine	
e. glue	water, alcohol, etc.	

Understanding solvents and solutes in terms of their solubility helps you to understand how some common household cleaners work. Most dirt is a mixture of greasy substances, protein, and dust. Detergents help to dissolve the dirt and get clothes clean.



Dry cleaning operations also choose solvents based upon solubility. The process was discovered accidentally in France in 1825. The maid of Jean-Baptiste Jolly, a dye factory owner, knocked over a paraffin lamp. The paraffin cleaned stains from the tablecloth. The idea of using paraffin to clean stains from fabrics soon spread all over the world. The process was called dry cleaning because no water is used. The solvents they use will dissolve oil and grease to get clothes clean but they do this without water which will not dissolve the oil anyway. For this reason, the dry cleaning process is often more effective than washing with water.



Many other solvents are used in industry and in your house. Some of these are very dangerous and should be used with great care. Car care products may contain turpentine and kerosene as solvents. Acetone is used in some glues and alcohol is a common solvent in many cosmetic lotions and hair care products. Many of the commonly used solvents can cause damage to human tissue and are flammable as well. Safety precautions should always be followed when using solvents.

Caution

Keep away from sparks or flames.
Use in a well ventilated area.
Use with gloves.

6. List the rules for the safe handling of solvents.

_____

_____

_____

No precautions need to be taken with the universal solvent – water. It is quite harmless.

Check your answers by turning to the Appendix, Section 3: Activity 1.

Activity 2: Temperature Effects

Another factor which affects how well solvents dissolve solutes is the temperature of the solvent.

Investigation: Solubility of Solids and Temperature Effects

If you try to mix sugar in cold water to make a drink, it will take a long time for the sugar to completely dissolve. Stirring may help to dissolve the solute. Is it possible to dissolve a greater amount of sugar in hot water than in cold water? How does the temperature of the solvent affect solubility?

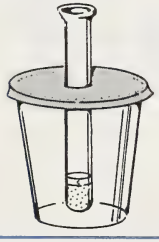
Materials You Need

- graduated cylinder or measuring spoons
- test tube rack or a wide, deep cup
- test tube
- rubber stopper
- test tube clamp
- small pan
- 15 mL sugar
- masking tape or wax crayon

Steps to Follow

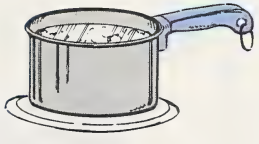
STEP A

Put the test tube in a cup or test tube rack. Add 15 mL of sugar to the test tube. Mark the level of the solid with a piece of tape or a wax crayon.



STEP B

Fill a small pot with water and set it on the stove to boil the water. The pan must be deep enough to set the test tube in it.



STEP C

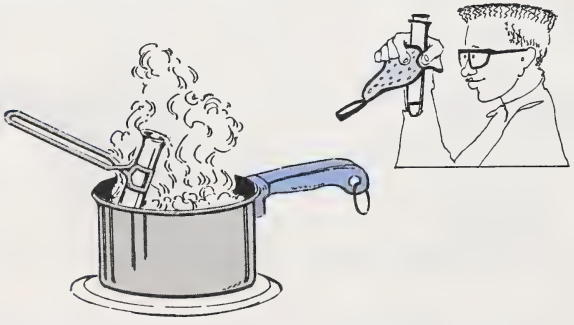
While waiting for the water to boil, add 10 mL of tap water to the test tube. Stopper the test tube and shake for about 1 minute to dissolve as much of the solid as possible. Mark the level of the solid using tape or a grease pencil.

OBSERVATION

1. Did any more of the sugar dissolve after shaking for 1 minute? Explain.

STEP D

When the water in the pot begins to boil, remove it from the heat. Take out the stopper and put the test tube into the pot of hot water for 1 minute. Use a test tube clamp to support the test tube in the pot. Remove the test tube from the hot water. Wrap a cloth or pot holder around the test tube to avoid burning your hand. Stopper the test tube, and carefully turn it upside down a few times. Note the level of the solid.



OBSERVATION

2. Did more sugar dissolve when the water was heated?

Why do you think this happened?

Conclusions

3. Make a general statement regarding the temperature of a solvent and the amount of solute that will dissolve.

_____

_____

The solubility of substances has a wide variety of applications in household processes. Cooking often involves making solutions with water as the solvent. By heating the water, more solute dissolves.

When gases dissolve, not quite the same results are seen. The following investigation will show you the difference.

Investigation: Solubility of Gases and Temperature Effects

Materials You Need

- two test tubes
- wide mouth glass or beaker
- 1/4 of an Alka-Seltzer tablet
- crushed ice
- small pan

4. Predict what you think will happen to the solubility of a gas when the temperature of the solvent is increased or decreased?

_____

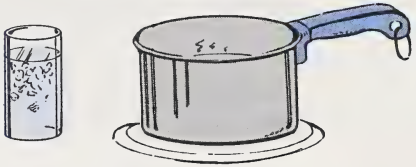
_____

_____

Steps to Follow

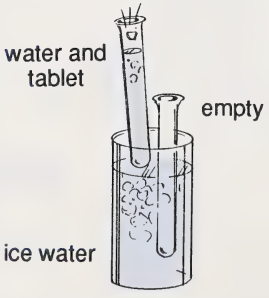
STEP A

Fill the wide-mouth glass or beaker with crushed ice and add some water. Fill a small pot 3/4 full of water and put it on the stove to heat. Wait until the water is almost boiling; then turn the heat down and proceed to step B.



STEP B

Fill one test tube almost full with cold water from the ice-filled glass. Drop in a 1/4 of an Alka-Seltzer tablet. Put the test tube into the ice-filled glass. Put the other empty test tube in the glass to get cold too.

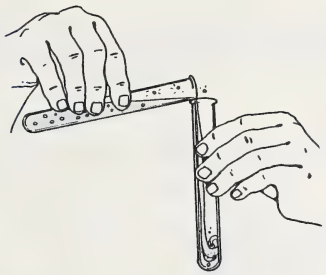


OBSERVATION

5. When the Alka-Seltzer was dropped into the cold water, it fizzed because carbon dioxide gas was being produced. Some gas goes into the air. Where does the rest of the gas go?

STEP C

When the tablet is almost finished fizzing, pour about half of the solution into the empty test tube. Set the first test tube back into the cold water.



STEP D

Put the bottom of the test tube into the hot water for a few seconds; then put it back into the cold beaker. Repeat a few times.

OBSERVATION

6. What happened when you put the bottom of the test tube into the hot water?

_____

_____

_____

Bubbles of gas escape from a solution because the solvent cannot dissolve anymore gas. When a cold gas-liquid solution is warmed, gas comes out of the solution and less gas is dissolved in the solvent.

Conclusions

7. Was the prediction that you made at the start of this investigation shown to be correct?

_____

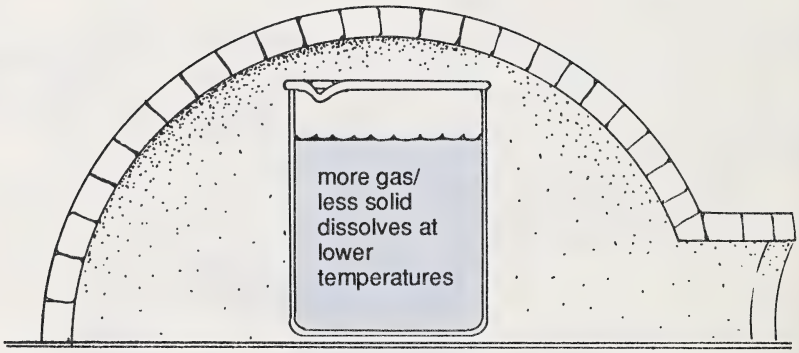
Many experiments like this have been done on various liquids and gases and the results are similar to the results for this investigation.

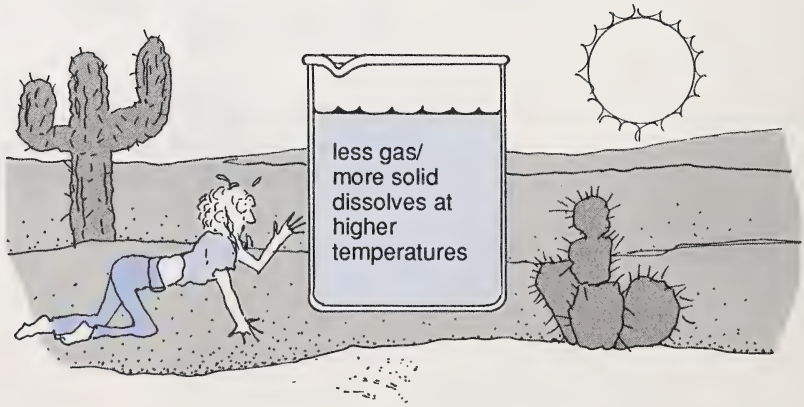
8. Make a general statement regarding the temperature of a solvent and the amount of gas that will dissolve.

_____

_____

_____





Do you like flat pop? Try this: Open a can (or bottle) of pop and pour about a quarter of a glass into two identical glasses. Leave one glass on the counter and the other glass in the refrigerator for at least 4 hours.

cold

warm

Taste each one to see which has more dissolved carbon dioxide gas left in solution. The one that tastes flat has the least gas dissolved. Which one tastes flat, the cold pop or the warm pop?

9. a. Would more solid dissolve in 100 mL of water at 25°C or 75°C?

_____

b. Would more gas dissolve in 100 mL of water at 25°C or 75°C?

_____

There is a point in the dissolving process when no amount of stirring will make more solid dissolve. If you want to get more of something to dissolve, what will you do? You now know that a change in the temperature of the solvent-solute system will change the amount of solute that can dissolve. You will explore this idea further in Activity 3.

Check your answers by turning to the Appendix, Section 3: Activity 2.

Activity 3: How Much?

So far you have been asked to consider mixtures where the solute will dissolve and mixtures where the solute will not dissolve at all. You observed that the temperature of the solvent has an effect on how much solute dissolves.

In this activity you will again study soluble substances in water. This time you will study it in terms of the amount of solute that can be dissolved in a given amount of water.

How much solid can be dissolved in a certain amount of water? This depends on the kind of solid and the temperature of the water. These two factors influence the **solubility** of a solute.

solubility - the ability of a material to dissolve in a solvent

Investigation: How Much Will Dissolve?

Different materials have different solubilities. In this investigation you will compare the solubilities of three substances (sugar, salt, and alum) to determine which solid is most soluble.

Materials You Need

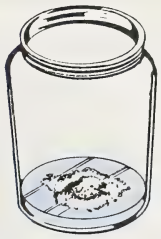
- 10 g alum (12 mL)
- 10 g salt (8 mL)
- 10 g sugar (12 mL)
- graduated cylinder or measuring spoons
- four small jars
- tape or wax crayon
- thermometer
- three small stirring spoons

Use only the amount of alum indicated. Save the alum solution and the extra alum for the Enrichment Activity.

Steps to Follow

STEP A

Fill a jar with water at 20°C. Then measure 25 mL into each of three jars. Measure the required amount of each solid, pour each solid into a different jar, and label each jar.



STEP B

Stir the contents of each jar for 2 minutes.

Observations

1. Rate the solubility of each solid by placing descriptive words in the table (*most*, *least*, etc.).

Substance	Solubility
salt	
alum	
sugar	

2. Did all of each solid dissolve? Explain.

_____

_____

_____

saturated solution - a solution that cannot dissolve any more solute

unsaturated solution - a solution that can dissolve more solute

A solution is said to be **saturated** when no more solute will dissolve. If more solute is added and it will not dissolve, the solution is saturated. An **unsaturated solution** has no undissolved solute. As long as more solute will dissolve, the solution is unsaturated.

3. Were any of the solutions in this investigation saturated? Explain.

_____

_____

4. Predict what would happen if you heated each of the solutions.

_____

_____

If you want to test your prediction, carefully warm each of the solutions in a hot water bath.

Caution: Never heat a solution with the lid on the container.

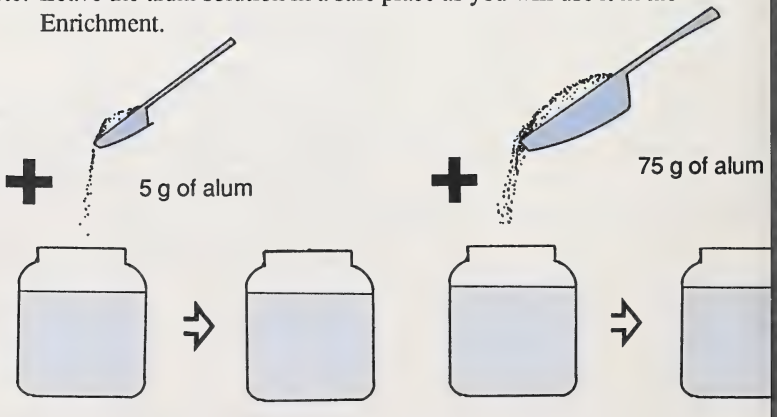
Conclusion

5. Make a general statement about the solubility of solids in water.

_____

_____

Note: Leave the alum solution in a safe place as you will use it in the Enrichment.



More solid will dissolve when the water temperature increases.

Investigation: Making a Solution You Can Eat

Have you ever made candy? What about puffed wheat or puffed rice squares? Many sweet things are made by dissolving sugar in water or another liquid and then cooking the mixture.

supersaturated solution - a solution that dissolves more material than a saturated solution at that temperature

In this investigation you will add sugar to hot water to make a saturated solution and then cool the saturated solution to make a **supersaturated** solution of sugar and water. This solution will be used to form candy and crystals.

Materials You Need

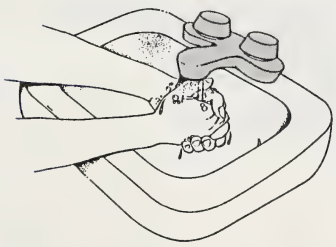
- 100 mL glass beaker or a small pot
- 30 mL sugar
- wooden stir stick
- measuring spoon or graduated cylinder
- stove or hotplate
- safety goggles
- candy thermometer with clamp (temperature scale must reach at least 115°C)

(If you don't have a candy thermometer, don't worry; you can do this investigation without it.)

Steps to Follow

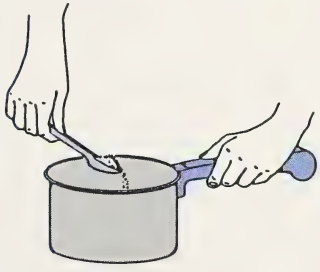
STEP A

Wash and rinse each piece of equipment well. Wash your hands too.



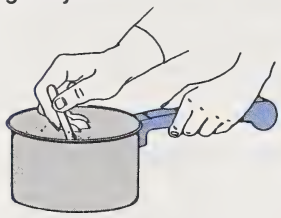
STEP B

Put 30 mL of sugar into a 100 mL glass beaker or a small pot, and add 15 mL of water.



STEP C

Gently heat the contents of the beaker or pot to boiling. Scrape the sides with the wooden stir stick to remove any stray sugar crystals.

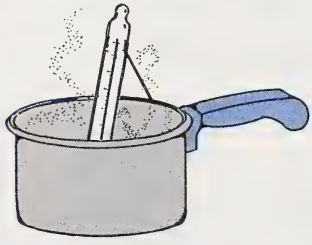


STEP D

Make sure all the sugar dissolves. Stir gently; don't splash.

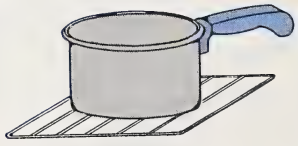
STEP E

Clamp the thermometer so it does not touch the bottom of the pot. Heat the mixture gently to a temperature of 114°C. (In candy-making language, this temperature is called the soft-ball stage. If you don't have a candy thermometer, cook the sugar solution until a drop forms a soft ball when it is put into cold water.)



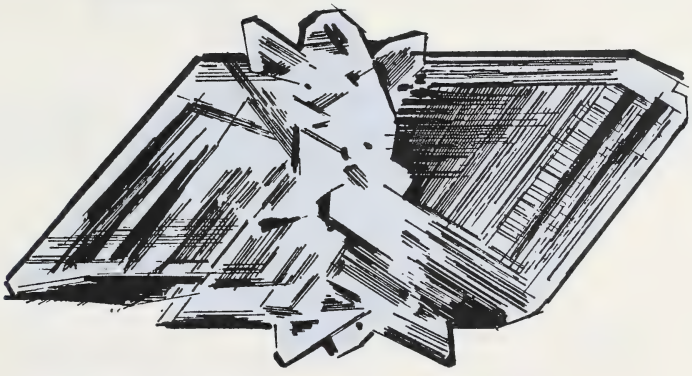
STEP F

Take the thermometer out of the solution and allow the pot to stand undisturbed for about 30 minutes or until it is cool.



The solution at 114°C was saturated with sugar. If the solution is undisturbed as it cools, it becomes supersaturated. More sugar is dissolved in the water than would be expected as the temperature decreases. This solution is not stable, so be careful! If you disturb it, some of the sugar will come out of the solution and reform solid sugar crystals. Actually, this is how you get rock candy to form. The sugar in the supersaturated solution recrystallizes over a few weeks, and if you set it up right, the sugar will form large crystals.

(Look for the recipe to make rock candy in the Appendix - Diagram 5.)

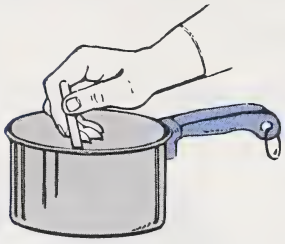


When formed slowly, large crystals will grow.

The candy you are making will take a very short time to form because the supersaturated solution will be stirred vigorously and form many tiny crystals very quickly.

STEP G

When the supersaturated solution is cool, stir it quickly with the wooden stir stick.



OBSERVATION

6. As you stirred the solution, what happened? Describe what you saw.

_____

_____

_____

7. Describe the texture of the candy. Explain why the crystals are small.

_____

_____

_____

Conclusions

8. How do crystals of different sizes form?

_____

_____

_____

9. Why is a supersaturated solution unstable?

_____

_____

_____

10. Explain the differences between unsaturated, saturated, and supersaturated solutions.

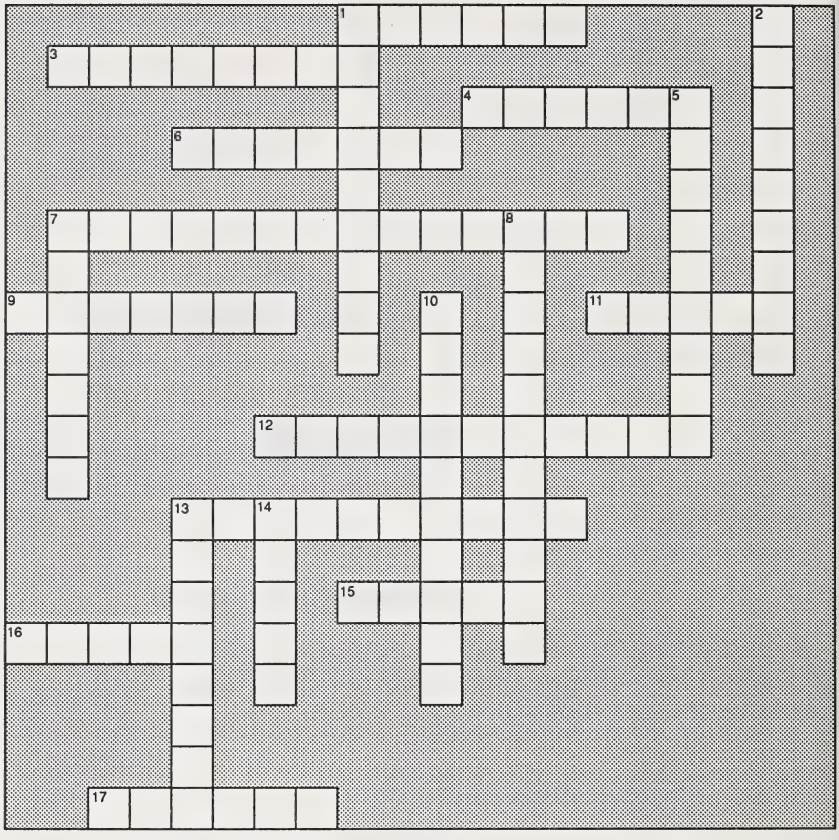
Check your answers by turning to the Appendix, Section 3: Activity 3.

Follow-up Activities

If you had difficulties understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

When you complete the following crossword puzzle, you will have reviewed what you need to know about the solubility of substances.



Across Clues

1. the part of a solution that dissolves
3. Sugar crystals will _____ in water.
4. Solvents that can catch on fire should be kept away from _____.
6. the part of a solution that particles dissolve in
7. when a solution holds more solute than it should at a certain temperature
9. a common solvent found in many lotions and hairsprays
11. _____ crystals form quickly.
12. A solution is _____ if the particles being added will still dissolve.
13. the ability of a substance to dissolve in a solvent
15. called the universal solvent
16. More gas can dissolve at a _____ temperature.
17. More solid can dissolve at a _____ temperature.

Down Clues

1. Solvents will dissolve only certain solutes. They are _____.
2. will not dissolve
5. when a solution has dissolved the most particles it can
7. will dissolve
8. one of the factors that influences solubility
10. use solvents in a well- _____ area
13. will speed up dissolving
14. _____ crystals form slowly.

Check your answers by turning to the Appendix, Section 3: Extra Help.

Enrichment

You learned how to make a solution hold more dissolved solute than it normally could hold at that temperature. These solutions are called supersaturated solutions.

In this activity you will grow a single crystal of alum. You could grow crystals using other solids but more effort will have to be put into the process.

Investigation: Making Large Crystals

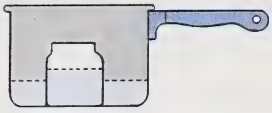
Materials You Need

- clean glass jar or beaker (You should have saved the jar and alum from a previous investigation.)
- 30 mL alum
- fine white thread (or thin fishing line)
- pencil
- hot water
- pot

Steps to Follow

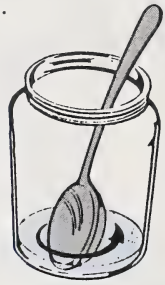
STEP A

Add water to the 150 mL mark in the glass jar or beaker. Place the jar into the pot so that the water level in the pot is close to, but not above, the water level in the jar. Heat the pot on the stove until the water is hot but not boiling.



STEP B

Add 30 mL of alum to the jar of water. Stir the alum until it is all dissolved. Remove from the heat.

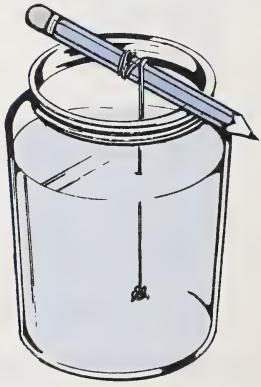


STEP C

Tie a few knots (on top of each other) to make a small lump in the thread or fishing line. Cut off the excess thread from the knots.

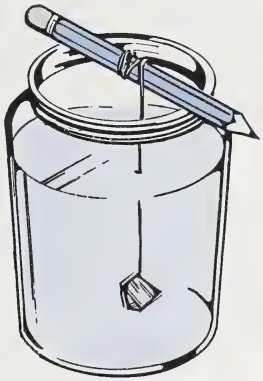
STEP D

Tie the thread or fishing line to the middle of the pencil. Drop the knot into the saturated solution of alum in the jar. Wind the thread on the pencil so that the knot hangs freely in the solution.



STEP E

Leave the apparatus overnight in a place where it will not be disturbed. The next day remove the thread with the forming crystals from the jar. Break off all the crystals on the thread except the one on the knots. Reheat the solution in the jar to dissolve all of the solid alum. Remove from heat and put the thread back into the solution. Repeat these daily processes until you get a crystal size to your liking.



1. The solution that you made is a supersaturated solution. Why do crystals form?

_____

_____

Sugar, salt, sand, and precious stones are crystals. Each crystal has its own shape. You may be able to see the crystal shape of the various materials by close inspection. (A magnifying lens may help.)

Check your answers by turning to the Appendix, Section 3: Enrichment.

Conclusion

How well something will dissolve depends on a number of different things. Stirring, changing the temperature, and breaking the solute into smaller pieces will make the solute dissolve better. Some things will simply not dissolve regardless of what is done to make them dissolve. The ability or inability of solutes to dissolve has important applications in industry, cleaning processes, and food preparation. In your household it may mean the difference between immaculate clean clothes and spotted ones. It allows you to make and eat things such as candy, pickles, and syrup. Understanding solubility allows you to decide which solvent is best for the dissolving process that must occur.

ASSIGNMENT

Turn to your Assignment Booklet and do the assignment for Section 3.

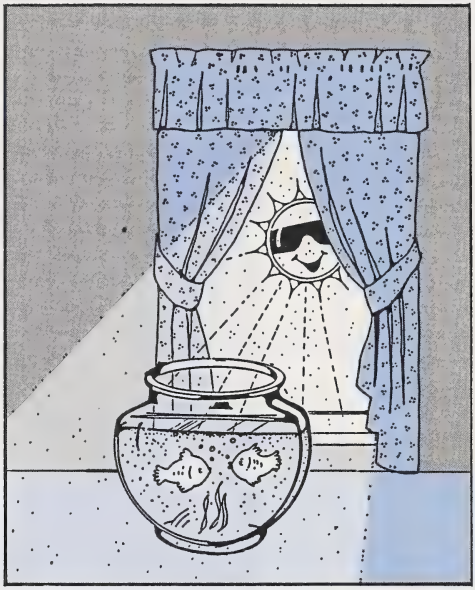
4 Suspensions

WESTFILE INC.

Have you had a sandwich lately? Did you put butter or mayonnaise on it? Maybe you had a glass of milk with the cookies you had for a snack. There are many foods in your house that are not pure substances or solutions. Milk, butter, and mayonnaise are mixtures, but they are not solutions because the particles are not completely dissolved. You will learn about the properties of these special mixtures and some common household examples in this section.

Activity 1: What Is It?

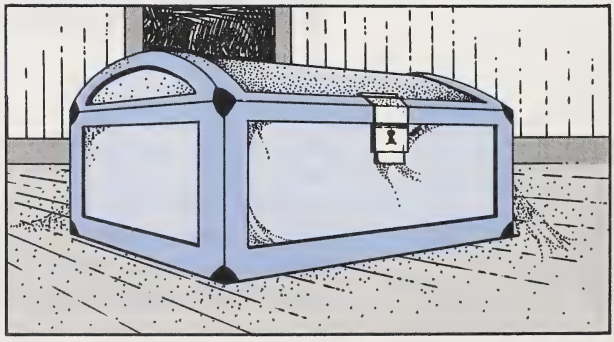
Look at the sunbeam of sunlight passing through your window.



You should be able to see small particles of dust suspended in the air. (If you can't see anything, jump on the rug a few times or shake a tissue in the air. You can also hit a chalkboard brush in front of a flashlight.) The dust particles seem to float in the air, some falling, some actually going up. This is called a **suspension** of dust in air.

suspension - very small particles held up in another substance

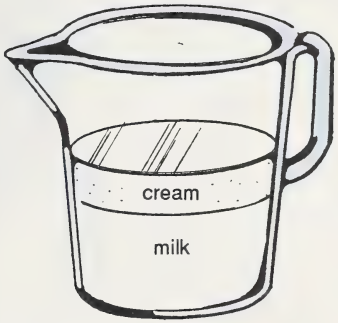
Does your house have a suspension of dust in the air? One way to find out is to look for the dust particles in a sunbeam or a flashlight beam. Another way is to check for dust on shelves or on the tops of doorways. If you find any dust in your house, the dust must have come from the suspended dust in the air which then settles out onto every surface in the house.



temporary suspension - a suspension in which particles will eventually separate

If the particles in a suspension are large enough to settle out it is called a **temporary suspension**.

Have you ever seen fresh, raw milk? Milk that has not been homogenized will separate into two main parts, milk and cream. All one has to do is leave the milk to sit in a cool place for about 12 hours. The lighter cream will rise to the top and the heavier milk will settle underneath the cream.



Therefore raw milk is another example of a temporary suspension.

permanent suspension - a suspension in which the particles will not settle

Why doesn't the milk you buy in the store also separate into milk and cream? The answer is that the milk has been homogenized. The large fat particles in the cream have been made smaller and uniformly spread throughout the milk. Homogenized milk is an example of a **permanent suspension**.

Have you ever seen fog? Most people have noticed a dense fog outside (usually early in the morning) or have been forced to stop driving because of a dense fog. Fog is a suspension of water droplets in air. Fog and clouds are the same suspension; fog is very close to the ground, while clouds are high above the earth.

When the particles of water in a cloud get large enough to fall, you see the result as rain. The particles of water are settling out of this suspension.

Investigation: Soil

In this investigation you will use ordinary garden or potting soil to produce a suspension, and you will investigate the properties of this suspension.

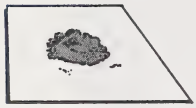
Materials You Need

- 10 mL of potting soil (or soil from a flower bed or garden)
- two glass jars (500 mL or larger) with lids
- paper coffee filter (or paper towel)

Steps to Follow

STEP A

Pour the soil sample onto a clean sheet of paper. Look closely at the soil and answer the questions.



OBSERVATION

1. Is the soil a pure substance or a mixture?

   _____

2. What do you think would happen if you added a small amount of water to the soil?

   _____

3. What do you think would happen if you added a large amount of water to the soil?

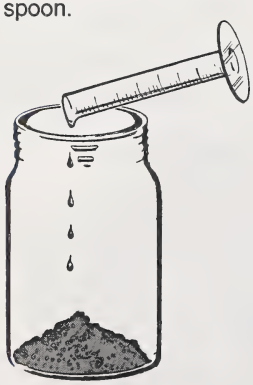
   _____

   _____

   _____

STEP B

Pour the soil into a jar and add 5 mL (1 teaspoon) of water to the soil. Stir with the spoon.



OBSERVATION

4. After the soil and water is stirred, is the result a mixture, a suspension, or a solution?

   _____

5. Explain your answer.

   _____

   _____

   _____

   _____

STEP C

Add 100 mL of water to the wet soil in step B. Screw the lid on the jar and shake the jar thoroughly.

OBSERVATION

6. After the soil and water is well mixed, is the result a mixture, suspension, or a solution?

_____

7. Explain your answer.

_____

_____

_____

_____

STEP D

Allow the jar and contents to sit undisturbed. After 30 minutes, observe the contents.

OBSERVATION

8. Draw a diagram of the jar and its contents after it has been left for 30 minutes.

STEP E

Use a paper coffee filter or a paper towel to filter the contents of the jar into another jar.

OBSERVATION

9. Describe the contents of the jar containing the filtered liquid.

_____

_____

_____

10. Describe what is trapped in the filter.

_____

_____

_____

Conclusions

11. What are two ways you can remove the particles from a suspension?

_____

_____

_____

_____

12. Could you use either of the methods in #11 to remove the solute from a solution? Explain.

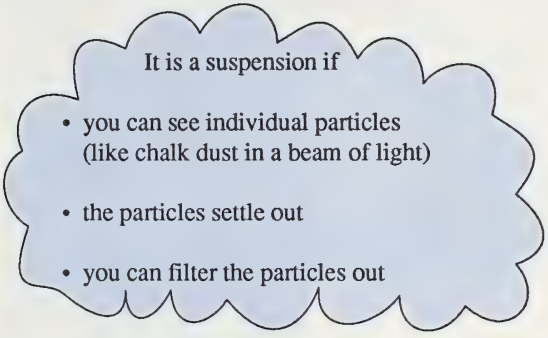
_____

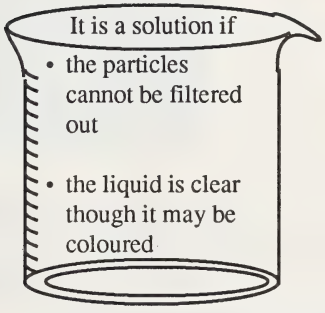
_____

Check your answers by turning to the Appendix, Section 4: Activity 1.

Activity 2: Solution or Suspension?

Solutions and suspensions must be different since they have different names. How can you tell one from the other? Sometimes it is not easy to tell. It can be difficult to tell the difference between a solution and a suspension because the particles may be too small to see, yet the substance may be a suspension. Here are some rules of thumb to tell the difference.


It is a suspension if
• you can see individual particles (like chalk dust in a beam of light)
• the particles settle out
• you can filter the particles out



You can also have a solution and a suspension at the same time. For example, homogenized milk has tiny droplets of fat suspended in a watery liquid. Also, many substances and elements are dissolved in the milk. Therefore milk is both a suspension and a solution at the same time. If you are asked to classify a substance as a suspension or a solution, apply these rules of thumb:

- Shine a light on the substance; if it appears cloudy or you can see particles in it, the substance is a suspension; if it is clear (may be coloured) it is a solution.

- Allow the substance to sit undisturbed; if some particles settle out it is a suspension. When you think about some of the items found in a normal household you will find many suspensions both permanent and temporary.

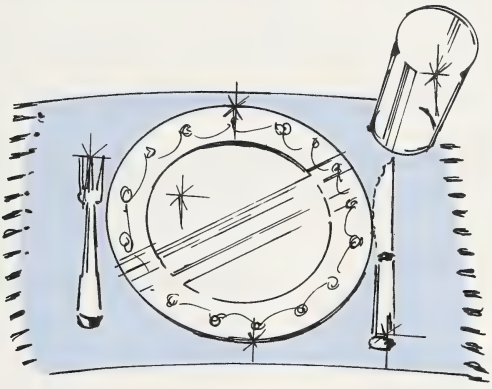
1. Classify the mixtures as either a suspension or a solution.

Mixture	Classification
a. house paint	
b. shaving cream	
c. ice cream	
d. shampoo	
e. antifreeze in your car	
f. tea	
g. baked cake	
h. toothpaste	
i. milk	
j. butter	

emulsifier - a substance that causes tiny particles of one liquid to be suspended in another

Temporary suspensions can be made into permanent suspensions by adding special chemicals called **emulsifiers**. Egg yolk in mayonnaise is an emulsifier. The vinegar and oil that makes up mayonnaise normally does not mix, but a chemical in the egg yolk keeps the oil and vinegar from separating.

Soaps and detergents are also emulsifiers. They work to make a permanent suspension of oil and grease. The oil and grease stay suspended in the water and not on the clothes. The water is then rinsed away and you have clean and greaseless clothes or sparkling clean dishes.



Investigation: Soap and Oil

Materials You Need

- test tube
- cooking oil
- liquid soap

Steps to Follow

STEP A	OBSERVATION
Place ten drops of cooking oil into the test tube. Add water until the test tube is half full. Cover the end of the test tube with your thumb and shake vigorously.	2. What do you observe? _____ _____ _____

STEP B	OBSERVATION
Add a few drops of liquid soap and shake well. Let stand for a few minutes.	3. What do you observe? _____ _____ _____

Conclusion

4. What effect does the soap have on the oil and water mixture?

_____

_____

gel - a jelly-like suspension

Another way to make a permanent suspension from a temporary suspension is to cause the mixture to thicken. A gel traps water particles and suspends them in the jelly-like solid. Jell-O™ is an example of a gel. Agar and gelatin are other examples. Can you think of more?

Temporary suspensions can be made permanent so that the particles do not settle. Two ways to do this are

- Make the particles smaller. This is done by shaking or using mechanical means to make the particles so small they take a long time to settle.
- Add special chemicals. Special chemcials stop the particles from separating or settling.

Check your answers by turning to the Appendix, Section 4: Activity 2.

Follow-up Activities

If you had difficulties understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

The exercise that follows deals with examples and properties of suspensions.

Match each term from this section with the statement and the examples that best describe it. Use each term three times – once for the definition and twice for two examples.

A. emulsifier

B. solution

C. permanent suspension

D. temporary suspension

E. gel

_____ 1. particles settle out

_____ 2. Jell-O™

_____ 3. clay and water

_____ 4. particles dissolve fully

_____ 5. salt water

_____ 6. milk

_____ 7. particles remain suspended

_____ 8. smoke in the air

_____ 9. special substance that causes particles to remain suspended

_____ 10. soda pop

_____ 11. egg yolk

_____ 12. gelatin

_____ 13. freshly squeezed orange juice

_____ 14. soap

_____ 15. jelly-like permanent suspension

Check your answers by turning to the Appendix, Section 4: Extra Help.

Enrichment

You have learned that solutions and suspensions are mixtures of substances. Sometimes the suspended particles are harmful or undesirable in a solution and must be separated.

A cook will drain the water from a mixture of macaroni and water. Industry will take old oil and separate the dirt from the oil in the recycling process. Your car engine has an air filter to separate the dust and dirt from the air before it enters the engine.

filter - a material with small holes in it used to separate suspended solids from a liquid or gas

Investigation: Solution or Suspension?

Materials You Need

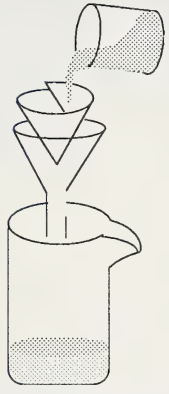
- 5 mL instant coffee
- one tea bag
- orange
- 5 mL sugar
- cup
- glass
- spoon
- filter paper
- funnel

Steps to Follow

STEP A	OBSERVATION
Place half a teaspoon of instant coffee in the cup. Add about half a cup of water and stir well with a spoon. Record your observations of the mixture.	1. What does the mixture look like? _____ _____ _____ _____

STEP B

Filter the contents of the cup into a glass.



OBSERVATION

2. What is trapped in the filter paper?

_____

_____

_____

3. What has passed through the filter paper?

_____

_____

_____

STEP C

Discard the filter paper, wash all utensils, and repeat steps A and B using sugar.

OBSERVATION

4. What does the mixture look like?

_____

_____

_____

5. What is trapped in the filter paper?

_____

_____

_____

6. What has passed through the filter paper?

_____

_____

_____

STEP D	OBSERVATION
Discard the filter paper and wash all the utensils. Break the tea bag and repeat steps A and B using tea leaves.	7. What does the mixture look like? _____ _____ _____ 8. What is trapped in the filter paper? _____ _____ _____ 9. What has passed through the filter paper? _____ _____ _____

STEP E	OBSERVATION
Discard the filter paper and wash all the utensils. Cut the orange in half and squeeze as much as you can into the cup. Repeat steps A and B using freshly squeezed orange juice.	10. What does the mixture look like? _____ _____ _____ 11. What is trapped in the filter paper? _____ _____ _____ 12. What has passed through the filter paper? _____ _____ _____

Conclusions

13. Which of the mixtures were solutions?

_____

_____

14. Which of the mixtures were suspensions?

_____

_____

15. Does filtration work to separate all mixtures?

Check your answers by turning to the Appendix, Section 4: Enrichment.

Conclusion

You have learned in this section that many of the mixtures in and around your home do not form solutions. Instead they are temporary or permanent suspensions where the particles may be large, held up in a substance, and not dissolved. Suspensions are common mixtures that you encounter and use every day.

Assignment Booklet

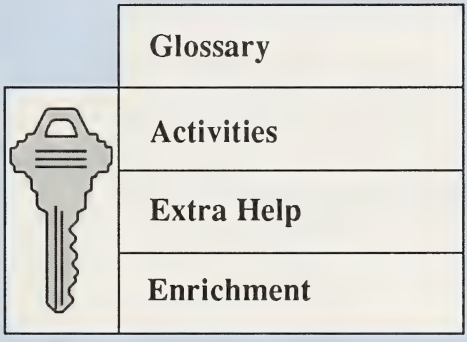
ASSIGNMENT

Turn to your Assignment Booklet and do the assignment for Section 4.

MODULE SUMMARY

There are many things that you do and use each day that are based upon scientific principles and processes. Measurement is important for being able to describe how big something is and to be a wise consumer in the marketplace. Many of the household processes that occur in and around your home involve mixtures, whether they be solutions or suspensions. The different types of solutions and suspensions make your life easier and more pleasant.

Appendix



Glossary

alloy
- a solution of metals

acrostic
- a composition in which letters taken in order form a word

area
- the number of square units a surface occupies; $A = l \times w$

atom
- the smallest particles that make up matter

axes
- the horizontal and vertical lines on a graph that give the measures of information to be displayed on the graph

classify
- to arrange or put into an organized manner

classification tree
- an orderly arrangement of classes listed from general to specific

compound
- a combination of two or more elements joined together

compress
- to press or squeeze together

displacement
- the difference between the initial volume and the final volume

dimension
- a measured amount such as width, length, and height

element
- a substance which cannot be split into simpler form

emulsifier
- a substance that causes tiny particles of one liquid to be suspended in another

estimation
- a guess or rough calculation of an amount

Fahrenheit
- the units for temperature measure in the Imperial System Freezing point for water is 32° F, and the boiling point is 212° F in this system.

filter
- a material with small holes in it used to separate suspended solids from a liquid or gas

gel
- a jelly-like suspension

heterogeneous
- varies in properties and composition from one part to another

homogeneous
- has the same properties and composition throughout

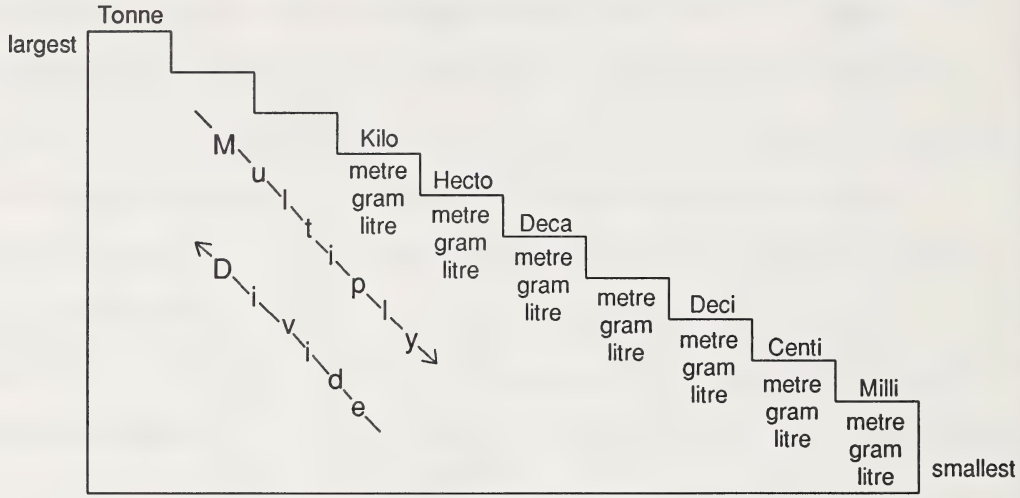
insoluble	• incapable of dissolving in a solvent
mass	• the amount of matter contained within something
matter	• anything that has mass and takes up space
mixture	• two or more substances that are blended together but not joined; parts can be separated out
molecules	• particles made from two or more atoms joined together
Periodic Table of Elements	• an arrangement of all the elements in order of atomic number
permanent suspension	• a suspension in which the particles will not settle out
pure substance	• a material which contains only one element or compound
saturated solution	• a solution that cannot dissolve any more material
selective	• has the ability to dissolve only a certain kind of substance
SI (metric) system	• a system of measurement based upon 10s; used in Canada for measurement
solubility	• the ability of a material to dissolve in a solvent
soluble	• able to dissolve
solute	• the part that dissolves in a solution
solution	• a mixture of materials that do not separate when left standing
solvent	• the part of a solution that dissolves the solute
supersaturated solution	• a solution that dissolves more material than a saturated solution at that temperature
suspension	• very small particles held up in another substance
synthetic	• man-made; does not occur naturally
temporary suspension	• a suspension in which particles will eventually separate out
thermometer	• a device for measuring temperature The unit of temperature used in Canada is °C.

thermostat	• a device used for automatically regulating the temperature in an appliance or in the home
universal solvent (water)	• the most common solvent; able to dissolve many things
unsaturated solution	• a solution that can dissolve more solute
volume	• a measure of the amount of space that something takes up
weight	• the force exerted on a body by gravity

Diagram 1

The Metric System

Step Chart



To change the units from **smaller to larger**, you divide by 10 for each step up.

To change the units from **larger to smaller**, you multiply by 10 for each step down.

Metric Ruler

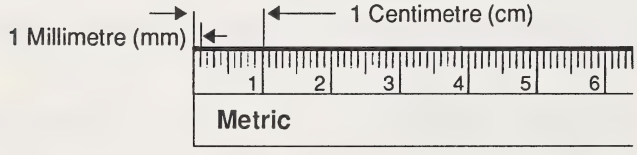
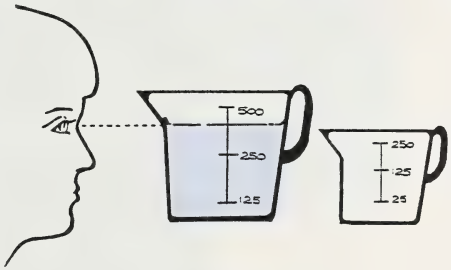


Diagram 2

Measuring Equipment

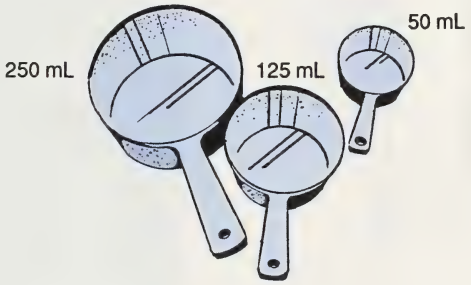
Liquid Measures

Measurements of liquids should be read at eye level. The 500 mL line is a little below the rim so that the liquid will not spill over. Read the volume at the bottom of the curve.



Dry Measures

The 250 mL line is right at the rim for easy levelling off. The dry measure set includes a 250 mL, a 125 mL, and a 50 mL measure.



Small Liquid and Dry Measures

The set includes five measures: 1 mL, 2 mL, 5 mL, 15 mL, and a 25 mL measure.

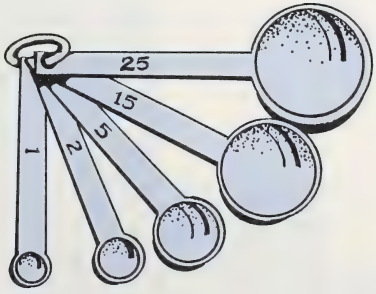


Diagram 3

Periodic Table of Elements

number of protons — 1
symbol — H
name — hydrogen

1 H hydrogen																	2 He helium
3 Li lithium	4 Be beryllium											5 B boron	6 C carbon	7 N nitrogen	8 O oxygen	09 F fluorine	10 Ne neon
11 Na sodium	12 Mg magnesium											13 Al aluminum	14 Si silicon	15 P phosphorus	16 S sulfur	17 Cl chlorine	18 Ar argon
19 K potassium	20 Ca calcium	21 Sc scandium	22 Ti titanium	23 V vanadium	24 Cr chromium	25 Mn manganese	26 Fe iron	27 Co cobalt	28 Ni nickel	29 Cu copper	30 Zn zinc	31 Ga gallium	32 Ge germanium	33 As arsenic	34 Se selenium	35 Br bromine	36 Kr krypton
37 Rb rubidium	38 Sr strontium	39 Y yttrium	40 Zr zirconium	41 Nb niobium	42 Mo molybdenum	43 Tc technetium	44 Ru ruthenium	45 Rh rhodium	46 Pd palladium	47 Ag silver	48 Cd cadmium	49 In iridium	50 Sn tin	51 Sb antimony	52 Te tellurium	53 I iodine	54 Xe xenon
55 Cs cesium	56 Ba barium	71 Lu lutetium	72 Hf hafnium	73 Ta tantalum	74 W tungsten	75 Re rhenium	76 Os osmium	77 Ir iridium	78 Pt platinum	79 Au gold	80 Hg mercury	81 Tl thallium	82 Pb lead	83 Bi bismuth	84 Po polonium	85 At astatine	86 Rn radon
87 Fr francium	88 Ra radium	103 *Lr* lawrencium															

57 La lanthanum	58 Ce cerium	59 Pr praseodymium	60 Nd neodymium	61 *Pm* promethium	62 Sm samarium	63 Eu europium	64 Gd gadolinium	65 Tb terbium	66 Dy dysprosium	67 Ho holmium	68 Er erbium	69 Tm thulium	70 Yb ytterbium
89 Ac actinium	90 Th thorium	91 Pa protactinium	92 U uranium	93 *Np* neptunium	94 *Pu* plutonium	95 *Am* americium	96 *Cm* curium	97 *Bk* berkelium	98 *Cf* californium	99 *Es* einsteinium	100 *Fm* fermium	101 *Md* mendelevium	102 *No* nobelium

Diagram 4

Metric Conversion

Teaspoons/Tablespoons

1/4 teaspoon	1.2 millilitres
1/2 teaspoon	2.4 millilitres
1 teaspoon	4.7 millilitres
2 teaspoons	9.4 millilitres
1 tablespoon	14.2 millilitres

Cups

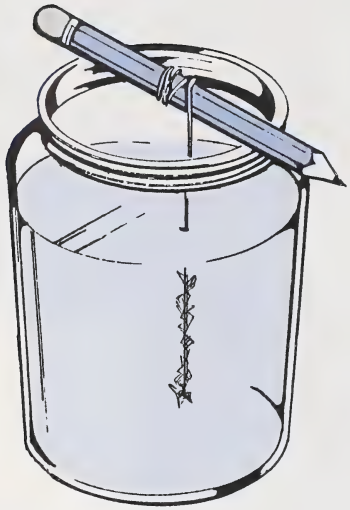
1/4 cup (4 T)	56.8 millilitres
1/3 cup (5 1/3 T)	75.6 millilitres
1/2 cup (8 T)	113.7 millilitres
2/3 cup (10 2/3 T)	151.2 millilitres
3/4 cup (12 T)	170.5 millilitres
1 cup (16 T)	227.3 millilitres

Oven Temperatures

Fahrenheit	Celsius
275°F	135°C
300°F	150°C
325°F	163°C
350°F	177°C
375°F	190°C
400°F	205°C
425°F	218°C
450°F	233°C

Diagram 5

Homemade Candy



Most cheap candies are simply large crystals of sugar that have flavour and colouring added. You can make your own candy using the same method used to grow the alum crystal.

In a small pot heat 125 mL of water. As the water is heating add 250 mL of sugar to the water, stirring as you add the sugar. Heat until the solution starts to boil and continue boiling for about one minute.

Pour the solution into a clean 250 mL beaker (or jar) and suspend a string into the solution using a pencil. Leave the crystals to grow undisturbed in a clean location. When the crystals get large enough you can break them off, ready to eat.

Suggested Answers

Section 1: Activity 1

1. • driving (how much farther to go)
   • sewing
   • exercising (running, jogging, track and field)
   • buying clothes (clothing sizes: waist and leg)
   • measuring your height or foot (shoe size)

2. mm (millimetre), m (metre), cm (centimetre), km (kilometre)

3.

Measurement	m	cm	mm
height of a doorway	2.03 m	203 cm	2030 mm
your height	1.4 - 1.8 m	140 cm - 180 cm	14000 mm - 18000 mm
length of a pencil	0.10 - 0.20 m	10 - 20 cm	100 - 200 mm
length of a vehicle	4 m	400 cm	4000 mm
width of piece of paper	0.21 m	21 cm	210 mm
width of your window	1.22 m	122 cm	1220 mm
length of your foot	0.20 m +	20 cm +	200 mm +
width of a picture frame	(large variations)		
length of a nail or pin	0.05 - 0.10 m	5 - 10 cm	30 - 100 mm
width of your bed	1.32 m	132 cm	1320 mm
width of your room	3.7 m	370 cm	3700 mm
length of your room	3.0 m	300 cm	3000 mm

All these answers are typical values. Your answers may vary somewhat, but make sure when you look at your answers that mm are 1000 × greater than m, and cm are 100 × greater than m.

4. a. accurate • when getting a new window, curtains, or blinds
   estimate • when deciding how much paint to buy to repaint your room or windows

   b. accurate • when buying shoes
   estimate • when buying socks

5. $A = l \times w$
   $A = 4.5\ m \times 3\ m$
   $A = 13.5\ m^2$

   You would have to buy 14 m^2 of sod to resod the grass.

6. a. You would require a blind that is 2 m × 1 m.

   b. The bath mat would have to be less than 2 m in length.

   c. Living Room Dimensions – length = 4 m
   width = 2 m

   $A = l \times w$
   $= 4\ m \times 2\ m$
   $= 8\ m^2$

   The living room requires 8 m^2 of carpet.

   d. Wall Dimensions – length = 2.5 m
   width = 2.0 m

   $A = 2.5\ m \times 2.0\ m$
   $= 5.0\ m^2$

   The living room wall labelled **W** would require 5.0 m^2 of wallpaper.

   e. Your new refrigerator could be 2 m tall.

Section 1: Activity 2

1. The following are examples of things measured in litres or millilitres: milk, gas, motor oil, pop, juice, vanilla, syrup, cooking oil, liquid soap, window cleaner, vinegar, antifreeze, and windshield washer.

2. You should have variation – some coffee cups are larger than others. You may find some cups that may be used for baking.

Investitation: Are You Getting What You Pay For?

Conclusions

3. The difference from the volume stated was probably not great. The container is usually slightly larger than the stated volume.

4. Yes, it's important to know how much of a product is in a container. Some packages are made larger but are not filled with the product.

5. a. length = 9.6 cm
   width = 9.6 cm
   height = 21.5 cm

   b. $V = l \times w \times h$
   $V = 9.6\ cm \times 9.6\ cm \times 21.5\ cm$
   $V = 1981\ cm^3$
   $(1000\ cm^3 = 1L)$

   The volumes are close to the same. The carton bulges on the sides when full, which allows for more milk to be put into the carton.

6. a. $l = 1.5\ cm$
   $w = 1.5\ cm$
   $h = 1.5\ cm$

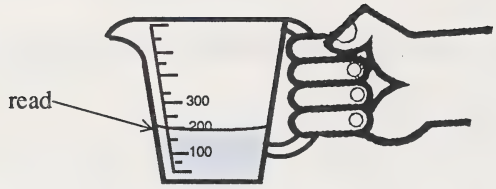
   $V = l \times w \times h$
   $V = 1.5\ cm \times 1.5\ cm \times 1.5\ cm$
   $V = 3.4\ cm^3$

   b. $$\frac{15\ ml}{3.4\ mL / sugar\ cube} = 4.4\ sugar\ cubes$$

   You would need about $4\frac{1}{2}$ sugar cubes to get a total of 15 mL.

7. 25 mL

8. a. 50 mL
   b. 75 mL
   c. 125 mL



Make sure you read at the bottom of the curve.

See the Appendix: Diagram 2 for further explanation on reading a measuring cup.

Section 1: Activity 3

1. a.
   - sugar – 1 kg, 2 kg, 5 kg, 10 kg
   - flour – 10 kg
   - salt for water softener – 10 kg, 25 kg
   - chips – 1 kg, 500 g
   - medicines – 75 mg
   - cookies – 750 g
   - coffee – 2 kg, 500 g
   - tea – 1 kg, 500 g
   - raisins – 400 g

   b. The gram (g) or kilogram (kg) are both common units of mass.

2. cornflakes (smallest mass)
   rice
   water
   sugar (largest mass)

3. a. Knowing the mass of a substance may be better because the volume of a container may be deceptive due to its shape.

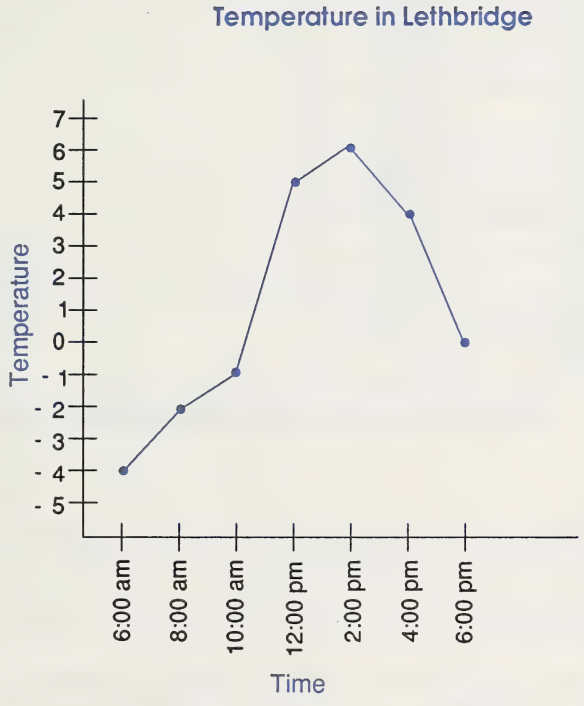
   b. Volume may be easier to estimate because masses of different things of the same size may be very different.

4. Mass is the amount of matter, and volume is how much space something occupies. A product that takes up a great deal of space may not have much mass, so you should be careful when comparing the volumes of things. They may be very different in mass.

Section 1: Activity 4

1. a. boiling point of water 100° C
   b. freezing point of water 0° C
   c. pleasant room temperature 20° C - 22° C
   d. your body temperature 37° C

2. a.

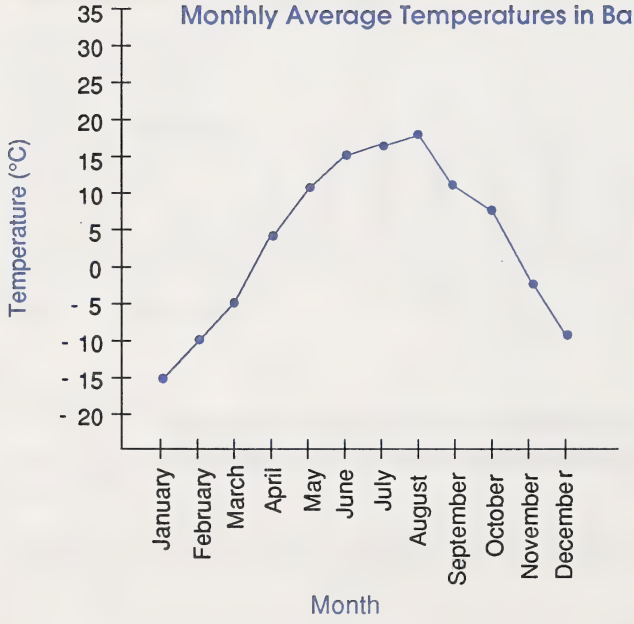


   b. • The temperature increases from 6:00 A.M. to 2:00 P.M.
   • The temperature decreases from 2:00 P.M. to 6:00 P.M.

3. a. Monthly Average Temperatures in Banff, Alberta

Month	Temperature (°C)
January	-15°C
February	-10°C
March	-5°C
April	4°C
May	11°C
June	15°C
July	17°C
August	18°C
September	11°C
October	8°C
November	-3°C
December	-10°C

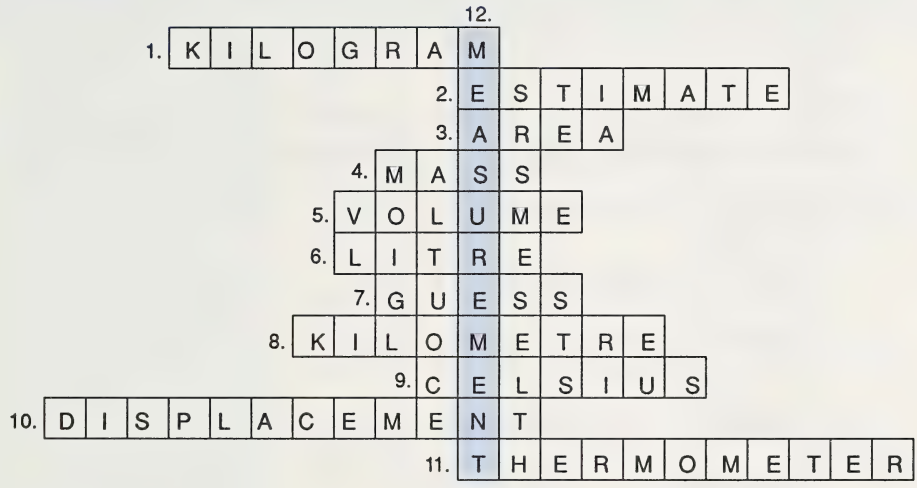
b.



c.
- The average temperature rises from January to August.
- The average temperature decreases from August to January.
- The average monthly temperature is above zero from April to October.
- The average monthly temperature is below zero from November to March.

Section 1: Follow-up Activities

Extra Help



12. HIDDEN WORD measurement

Enrichment

1. a. If you used feet or hands of about the same size, your measurements may be close, but if your foot or hand size differs much, your measurements would be different.

   b. It is not very reliable because everyone has different feet, arms, and hands.

   c. When people buy and sell products, they want to get a fair amount for the price. Using body units will mean that the amounts will vary depending on the size of the person doing the measuring.

Section 2: Activity 1

1. The homogeneous mixtures in the diagram are the coolaid and the pop.

2. The heterogeneous mixtures in the diagram are the mixed nuts, the tossed salad, and the salad dressing.

3. a. To separate the mixture, first let the sand go to the bottom and pour off the salt water. Let the water evaporate and the salt will be left on the bottom as a solid.

   b. To separate out the parts of a salad, you would pick out the individual parts.

Section 2: Activity 2

1. a. Cu
   b. O
   c. C
   d. Pb
   e. Ca

2. Any of the elements in this group are synthetic elements: #61, and 93-103.

3. a.

Elements	Compounds
silver	carbon dioxide
iron	chalk
mercury	water
gold	alcohol

   b.

Elements	Compounds
Anything on the periodic table can be listed here.	Make sure you list things that are not on the periodic table.

Section 2: Activity 3

1.

Solution	Solute	Solvent
a. coffee	coffee	water
b. oil and gas	oil	gas
c. water and air	water	air

Investigation: Water – A Universal Solvent? (Observations)

Substance Tested	Observations After Shaking for 1 Minute	Observations After Waiting for 2 Minutes
sugar	• water dissolved most of the sugar • clear and colourless*	• small amount of sugar on the bottom • clear and colourless solution
salt	• water dissolved most of the salt but water was cloudy	• still a bit cloudy • salt crystals at bottom of test tube
cooking oil	• oil was in little globs throughout the water	• oil has separated and gone to the top of the test tube
powdered soap	• most of the soap dissolved • bubbles at the top • cloudy solution	• clear solution • bubbles at the top • some powder has sunk to the bottom
flour	• some flour sticks to the bottom • bubbles on top; very white	• still cloudy • very little if any flour has dissolved
butter	• butter sticks to sides of test tube • breaks up into globs	• butter in globs in the water • no dissloving here
baking soda	• baking soda dissolves but makes a cloudy solution	• mostly a clear, colourless solution
rubbing alcohol	• mixes completely with water • colourless, some bubbles	• completely mixed • clear and colourless
turpentine	• cloudy mixture • globs of turpentine throughout water	• globs of turpentine throughout the water • most has risen to the top
vinegar	• mixes well • colourless solution	• completely mixed, clear, and colourless
cornstarch	• cloudy white mixture	• no mixing • still cloudy, cornstarch sunk to bottom
instant coffee crystals	• dark mixture • can't see through if too much coffee is dissolved	• dark solution • some undissolved
drink crystals	• mixes with water • some sinks to bottom, colour is colour of crystals	• coloured solution • most dissolved

*colourless means no colour - clear means you can see through it

Conclusion

2. a. No, many substances dissolve partially, like baking soda and coffee. Some do not dissolve at all, like oil, butter, turpentine, and cornstarch, so they don't form water solutions.

   b. Solutions are clear (you can see through them), not cloudy.

3. Some substances might, you will test this in Section 3.

4. The solutes and solvents must be similar types of substances to dissolve in each other.

Section 2: Follow-up Activities

Extra Help

1. element
2. compound
3. mixture
4. two
5. solute
6. solvent
7. water, universal
8. selective
9. matter
10. heterogeneous, homogeneous
11. classify
12. elements

Enrichment

Investigation: Properties of Water in Solutions

STEP E OBSERVATION

Freezing Point of Water	0°C or close to that
Salt Solution Temperature	lower than 0°C and lower than the temperature of the sugar solution
Sugar Solution Temperature	lower than 0°C but higher than the temperature of the salt solution

1. The freezing point of water is decreased.

2. Yes, more sugar caused the freezing point to decrease.

STEP H OBSERVATION

Boiling Point of Water	close to 100°C
Boiling Point of Salt Water	higher than 100°C

3. The boiling point of water increases when salt is added.

Conclusions

4. The freezing point will decrease.

5. The freezing point will decrease and the liquid solution will not freeze in very cold weather.

6. The boiling point will increase.

7. Antifreeze added to water increases the boiling point of the water so that the cooling system will not boil over in very hot weather.

Section 3: Activity 1

1. a. The following substances are insoluble in water: oil, butter, cornstarch, and turpentine.

   b. Some substances which are soluble in water are sugar, salt, alcohol, vinegar, drink crystals, and soap.

Investigation: Solutions and Dissolving – Other Solvents

Observations

Substances to Be Mixed solute – solvent	Observations After Shaking for 1 Minute	Observations After Waiting for 2 Minutes
oil – water	globs of oil not dissolving	does not dissolve
oil – turpentine	oil dissolves	dissolved, clear
butter – water	small blobs but did not dissolve	does not dissolve
butter – turpentine	butter dissolves	dissolves
sugar – water	dissolves, clear	no further change
sugar – rubbing alcohol	nothing observed	no dissolving
salt – rubbing alcohol	nothing observed	no dissolving
salt – water	dissolves, clear	no change
powdered soap – water	solution formed	soap stays dissolved
powdered soap – turpentine	they mix and form bubbles	stays mixed

Conclusion

2.

Soluble	Insoluble
oil - turpentine	oil - water
butter - turpentine	butter - water
sugar - water	sugar - alcohol
salt - water	salt - alcohol
powdered soap - water	
powdered soap - turpentine	

3. Some of the substances insoluble in water were soluble in other solvents. Oil was insoluble in water but it did dissolve in turpentine. Sugar and salt were soluble in water but not in alcohol.

4. Soap dissolves the oil and also dissolves in water so that the soap and grease solution can be washed away.

5.

Picture	Solvent	Solute
a. nail polish remover	trichloroethane	fingernail polish
b. suntan lotion	alcohol	oils in the lotion
c. iodine solution	alcohol	iodine
d. car wax	turpentine	oils and waxes
e. glue	water, alcohol, etc.	gelatin

6. • Use in a well-ventiliated area.
   • Keep away from sparks and flame.
   • Use gloves to protect flesh.

Section 3: Activity 2

Investigation: Solubility of Solids and Temperature Effects

1. More sugar does dissolve (after shaking for 1 minute).

   Shaking seems to promote dissolving by making the dissolved solute evenly distributed.

2. Yes, more sugar dissolved when the water was heated.

   This is probably due to the greater randomness of the liquid and solid particles.

Conclusion

3. The higher the temperature, the more solute that will dissolve.

Investigation: Solubility of Gases and Temperature Effects

4. When the temperature of the solvent is increased, less gas can be dissolved.

5. The rest of the gas that was produced went into the water (dissolved in the water).

6. The solution started to bubble more and gas was given off.

Conclusion

7. If you predicted that less gas would dissolve in warm water you were correct. However, you may have thought that gases were the same as solids, which is not correct based on this investigation.

8. The higher temperature allows less gas to be dissolved. Lower temperature allows more gas to be dissolved in the solvent.

9. a. More solid would dissolve at 75°C.

   b. More gas would dissolve at 25°C.

Section 3: Activity 3

Investigation: How Much Will Dissolve?

Observations

1.

Substance	Solubility
salt	medium
alum	least
sugar	most

2. Most of the sugar dissolved, about half of the salt dissolved, and only a little of the alum dissolved.

3. All the solutions were saturated because no more of the solid was dissolving. (Some was left on the bottom.)

4. If you heated the solutions, more of the solid would dissolve.

Conclusion

5. Solids all have different solubilities in water. Some solids dissolve well and others hardly dissolve at all.

Investigation: Making a Solution You Can Eat

6. The supersaturated solution started turning solid again. As you stir the solid, it turns cloudy and finally almost white and creamy.

7. The candy texture is smooth. The crystals are small because they formed very quickly.

Conclusion

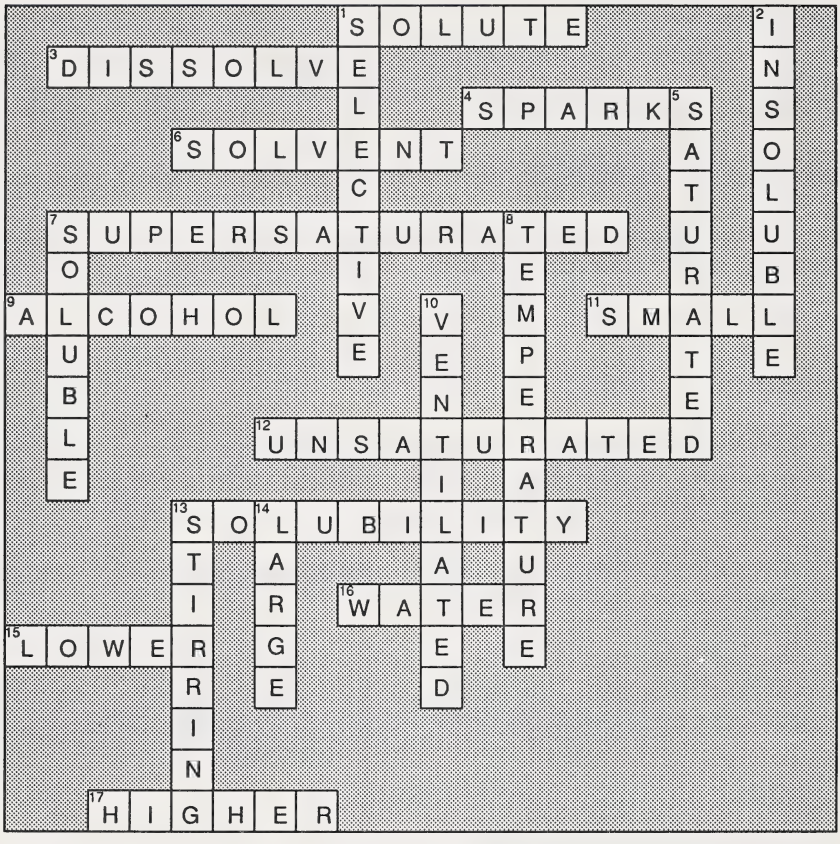
8. Different crystal sizes form depending on how long the supersaturated solution remains undisturbed. Small crystals form if the crystals are forced to form quickly. The longer the time to form, the larger the crystal size will be.

9. A supersaturated solution is unstable because it is holding too many dissolved particles for that amount of solute at that temperature.

10. Unsaturated solutions do not have as much solid dissolved as possible, more could dissolve. Saturated solutions have the maximun amount of solute dissolved and supersaturated solutions have more solute dissolved than there should be at that temperature.

Section 3: Follow-up Activities

Extra Help



Enrichment

Investigation: Making Large Crystals

1. Crystals form in the supersaturated solution because the solvent is holding too much solute and is therefore unstable. Crystals form because the extra solute cannot stay dissolved anymore and it recrystallizes.

Section 4: Activity 1

Investigation: Soil

1. Soil is a mixture. You should be able to see sand, organic particles, and a variety of other substances mixed together.

2. The soil would turn into a muddy mixture.

3. The water would dissolve the soluble parts of the soil, very light organic parts would float, the dense sand and clay would remain on the bottom, and the water would turn to a muddy colour.

4. mixture

5. The result is a mixture which should look like mud. The soil particles and water are mixed with little evidence of a suspension or a solution.

6. suspension

7. You can see the dark particles suspended in the water; light does not pass through the liquid.

8.

9. The water should be somewhat darker looking than clean water, but you should not be able to see any large particles suspended in the liquid.

10. The filter should contain a mass of sediment and the material which floated on the water.

Conclusions

11. • Let the heavier particles settle out on the bottom.
    • Filter the suspension to trap the larger particles and separate them from the liquid.

12. No, you could not since the solute will not settle out of a solution nor can you filter the solute out of the solution.

Section 4: Activity 2

1.

Mixture	Classification
a. house paint	suspension
b. shaving cream	suspension
c. ice cream	suspension
d. shampoo	suspension
e. antifreeze in your car	solution
f. tea	solution
g. baked cake	suspension
h. toothpaste	suspension
i. milk	suspension
j. butter	suspension

Investigation: Soap and Oil

2. The oil and water separate. The oil floats on the water.

3. The oil and water tend to mix when the soap is added.

Conclusion

4. Soap causes the oil to be suspended in the water.

Section 4: Follow-up Activities

Extra Help

1. D
2. E
3. D
4. B
5. B
6. C
7. C
8. C
9. A
10. B
11. A
12. E
13. D
14. A
15. E

Enrichment

Investigation: Solution or Suspension?

1. The mixture looks like a dark-coloured solution.

2. You might see some dark-coloured material trapped in the filter paper.

3. A coffee-water solution has passed through the filter paper.

4. The mixture looks like a clear solution.

5. Nothing is trapped in the filter paper.

6. A sugar and water solution has passed through the filter paper.

7. The mixture look like a light-coloured solution with tea leaves suspended and floating in it.

8. tea leaves

9. A light-coloured solution has passed through the filter paper.

10. an orange-coloured solution with particles suspended in it

11. Particles of orange fruit pulp are trapped in the filter paper.

12. An orange-coloured solution has passed through the filter paper.

Conclusions

13. The coffee and sugar mixtures are solutions.

14. Tea and orange juice are suspensions.

15. No, filtration does not work to separate the solute and solvent in solutions. Filtration will only separate the suspended particles from a liquid or gas suspension. You might have correctly argued that tea and orange juice were also solutions because they were both a suspension and a solution.

N.L.C. - B.N.C.
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